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Edward, W.G.

Improvement curves

in typewriting

Improvement Curves

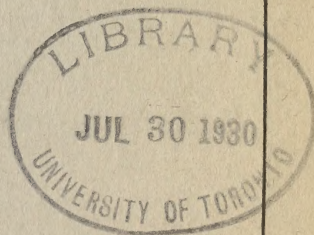
IN THE

Learning of Typewriting

By
W. G. EDWARD, B.A.

Head of Department of Typewriting
High School of Commerce
Toronto, Ont.

*Thesis for D. Paed. Degree
Univ. of Toronto*



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A thesis submitted in conformity with the requirements for the Degree
of Doctor of Pedagogy in the University of Toronto.

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PREFACE

The purpose of this dissertation is to determine and show how far improvement curves in the learning of touch typewriting by students at the High School of Commerce, Toronto, Ont., conform to the established characteristics of practice curves in general; and to investigate and show graphically, where possible, what effect sex, age, race, mental ability, day and evening sessions, relearning, piano playing, selection of practice material, errors, and elimination of students have on improvability in typewriting in this school.

Although no attempt has been made to establish definite norms for prognostic purposes, except in the case of the number of errors a senior student should make in a fifteen-minute test from new matter, it is hoped that the results of the experiments described may serve the educational purpose of arousing in teachers who read this thesis an inquiring attitude of mind which may lead to comparisons with their work, if the character of their schools and courses is similar.

I wish to thank Miss L. Dickson and Miss K. Kenyon, assistant day teachers, for their faithful and systematic assistance during the past three years and two years, respectively; also Miss R. Metcalfe, Mrs. McFarlane, and Mr. A. M. Kennedy, assistant evening teachers, for their regular and continuous help during the past year in securing, from the typewritten work done by classes in their charge, careful and minute records on the forms provided, which, combined with the writer's own records extending for ten years past, form the statistical basis of this dissertation.

I also wish to acknowledge the help received from the writings of other workers in the same field, especially those mentioned in the bibliography at the end of this thesis.

W. G. E.

Toronto, 1923.

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I.—HISTORICAL INTRODUCTION

The general characteristics of practice curves for measurement of improbability in efficiency in both mental and motor functions have been established by numerous experiments by various psychologists. The results of these experiments agree in showing (1) a rapid initial rise, (2) successive periods of no progress, or plateaus, followed by periods of more progress, (3) a gradual decline in the rate of improvement until a point is reached where further practice under ordinary conditions fails to produce much improvement, and finally (4) a straight line as the expert stage is reached with its physiological limit.

The following is a brief historical summary of all the previous psychological experiments in typewriting known to have been published:

In 1902 Dr. J. H. Bair, of Columbia University, published an account of certain experiments made on a single typewriter. He said the object of his experiments was to investigate various aspects of association—the relation among persistence of association, persistence of response, and the number of repetitions—and his general method was to measure the interference in efficiency caused by altering the order of a practised series of stimuli or required responses. Many kinds of experiments in association were made, such as repeating the letters of the alphabet in different orders, crossing out letters in different orders, filling in squares in different orders, tossing shot into a wine glass, and striking keys on a typewriter. To the carriage of the typewriter was attached an upright black screen which moved with the carriage and in which was a narrow slit the width of a letter printed by the typewriter. Immediately behind this screen was a horizontal cylinder held by a frame against the screen and covered with a white paper on which were printed several series of colors and characters. Certain keys were capped with similar colors. Every time a key was struck a different color and character appeared at the slot and indicated what characters and colors of keys should be the response. After practising one series till there were no errors at a certain rate, the order of the colors and characters was changed by turning the cylinder to show a different series, or the location of the colored caps was changed on the keyboard. Then the typing was resumed at the various rates by the help of a metronome, the number of errors was noted, and the number of repetitions necessary to type the new series with no errors at the same rate as the previous series was recorded. Thus the interference was made quantitative by noting the number of errors and necessary repetitions. While these experiments on the typewriter are admirable from the point of view of psychological investigation, their significance is questionable in connection with the learning of typewriting, since they introduce artificial conditions in equipment, copy to be typed, and in fingering required. It can readily be seen that an investigation of typewriting phenomena was not the chief end of the experiments, but that the use of the typewriter was only a means to a psychological end.

In 1904 E. J. Swift, of Washington University, St. Louis, practised one hour per day for fifty days by the sight method. He preserved a diary of introspective notes for most of the days of practice, and made a

psychological analysis of the same. His chief conclusion was that the learning process was irregular, owing to the presence of plateaus, the psychological reasons for which he went into very fully.

In 1906 Dr. W. F. Book, of the University of Montana, conducted the following experiments: (a) Two learners typed by the sight method for 87 and 43 hours respectively, and their scores were recorded daily for 10 minutes on repetition of the same practice sentence and for half an hour on copying new matter. (b) Two learners typed by the touch method for 130 and 60 hours, respectively, and their scores were recorded daily for 10 minutes on repetition of the same practice sentence and for one hour on copying new matter. (c) At another time a maximum of eleven subjects was used to get introspective data. (d) At six months, and again at a year and a half after the original experiments, ten daily tests were given to investigate relearning. In his experiments he had electrical connections between the operators and Deprez markers on a kymograph drum in order to get pulse records, and thus correlate pulse rate and efficiency. His dissertation, "The Psychology of Skill," is a very excellent psychological analysis of the learning consciousness obtained from introspective data, in order to arrive at an explanation of how typewriting habits are formed, and the subjective and objective factors influencing the learning of typewriting. He classified plateaus as occurring (a) within the course of every test, (b) from day to day, (c) at different stages of practice, and went exhaustively into their causes.

In 1907-8 L. B. Hill and A. E. Rejall learned to typewrite by the sight method, and kept careful notes of the time taken and errors made in typing (a) one same 100-word paragraph and (b) 300 words of changing material. Dr. E. L. Thorndike compared, analyzed and published these records in 1913. He examined the effect of Sunday's rest on Monday's work, and the effect of practice during illness. After four years and a half without practice, he again tested one of the subjects. His conclusions were: (a) There was a rapid initial rise in the learning curve, but absence of any clear plateaus. (b) There was a considerable permanence of learning shown in relearning. (c) In 40 hours of practice a beginner learned to typewrite as fast as he could write by hand.

In 1911-12 Dr. Peter Sandiford conducted an experiment with six students at Manchester University, using one Oliver typewriter. Five of these students were beginners, and the sixth had used a typewriter eight years before, but in the interval had not practised at all. They practised one hour per day for thirty consecutive school days, and scores were kept showing the total words typed and the errors made for each hour. His conclusions were: (a) The general form of the practice curve in typewriting was the same as other practice curves. (b) The percentage of errors decreased with practice. (c) The initial and final relearning scores were about double those of the beginners.

In 1919 J. Crosby Chapman, then of Western Reserve University, published an account of an experiment in typewriting completed about that time. Starting with the 20th hour of practice by the touch method, a class of students in a commercial high school were given a five-minute test from new matter, of about equal difficulty, once a week till 180 hours of practice were completed. Thirty-five students started in the experiment, but at the end of 110 hours only nineteen remained, and at the

end of 180 hours only nine students took the test. Scores were recorded showing the net number of words typed in five minutes, after deducting one for each error. These scores were used in drawing the learning curve for the students. Correlations were found among ability at the end of 35, 91 and 151 hours of practice. Chapman concluded: "Most of the subjects exhibit short plateaus which are probably genuine, but prolonged plateaus are notably absent, unless, as evidence seems to suggest, the period from 95-180 hours is considered as a long plateau from which the subject with great effort can rise."

This brief historical sketch serves to summarize the work already done in the field of typewriting by showing the purposes, methods, and results obtained by previous investigators, and also furnishes suggestions as to methods to be employed in future researches, either along the same lines for purposes of comparison, or in entirely new directions not yet explored.

The writer of this dissertation feels that in the chapters descriptive of investigation of piano playing, sex, race, age, day and evening sessions, elimination, choice of practice material, frequency of errors, correlation with mental ability, and practice extended over 360 hours, as factors influencing improvability in typewriting, he is making an original contribution to the known psychology of the subject, and, though the topics of his other two chapters have been dealt with by previous investigators, the technique and method of attack in the present researches are unique. In the problem of relearning, instead of giving a few tests to one or two individuals, 35 hours' work of ten students who failed in typewriting is compared with 35 hours' practice on the same work during the second year, and twenty students who failed in other subjects, but not in typewriting, are studied in the same way. In investigating the relation between speed and accuracy, the errors of ten students, who won Underwood awards of increasing value at 30, 40 and 50 net words per minute, are compared. All the experiments are free from artificial conditions and are regular class work. In order to make sure that the peculiarities of an individual were not being studied, 100 piano-playing girls, 100 non-piano-playing girls, 100 boys, 300 non-Jews, 50 Jews, 350 day students, 100 night students, and 30 relearners are included in the experiments. In order to make sure the whole learning curve was being studied, and not just a portion of it, practice extends over 360 hours or three school years in one experiment.

II.—INFLUENCE OF PIANO PLAYING

For some years past I have noticed that those learners who have succeeded in acquiring the greatest speed in typewriting have been students who have also been taking piano lessons. In all cases of this kind which have come under my notice, I have inquired whether in the opinion of such learners their previous acquaintance with piano playing has been of any help to them in learning to typewrite. The answer in every case has been in the affirmative. The object of this particular section of this paper is to try to find out what definite influence previous or contemporaneous knowledge and practice of piano playing exerts on improvability in typewriting in this school.

In all previous investigations with reference to the acquiring of skill in typewriting the study of the beginners' period has been neglected for the reason that, as it is impossible for a beginner to typewrite a paragraph of connected matter till he has mastered the whole keyboard, it is very hard to get continuous measurements of progress during this time. The writer is of the opinion that the beginners' stage in the learning of typewriting is of paramount importance, since the acquisition of speed later on depends on the foundation of accuracy laid in this period. In this school, in our day and evening sessions combined, we have twenty-three classes of beginners in typewriting, but only seven second-year classes, and two third-year classes. This preponderance in number of beginners makes it imperative to give a good deal of attention to this phase of the work, and the fact that the statistics and improvement curves for beginners working under various influences, as shown in later sections of this dissertation, are based on achievements in the elementary course is sufficient justification for going into the details descriptive of the work done, the material used in practice, and the method employed in mastering the keyboard for this particular investigation.

The elementary course mentioned above is used by all the beginners in typewriting in the High School of Commerce by special permission of the Ontario Education Department, and was devised by the writer of this dissertation. It has two unique commendable features: (1) the pedagogical arrangement of different words involving the same combinations of letters in order to produce maximum efficiency by repetition with attention, thus avoiding the thoughtless repetition resultant from repeating the same word line after line as in other textbooks; (2) the system of learning the keys in pairs while associating the corresponding fingers on the two hands with certain keys, thus allowing quicker co-ordinations than possible when a whole row of keys is learned horizontally.

The purpose of the elementary course for beginners is to master the keyboard by the touch method. This is done by learning a small part of the keyboard at a time, assigning certain keys to certain fingers, and practising on that section before going on to the next. For this purpose the work is divided into "budgets" or batches of pages to be done on each section. These pages are the units of work used in the measurement of the progress of the beginner. It makes no difference to an investigation of this kind whether the unit is a letter, a word or a page, so long as the same unit is used all the time for all the learners, since the achievement ratios would remain the same among the workers. Every page of every budget has fifteen typewritten lines of the same length, arranged in three groups of five lines each. The five lines in one group are all the same, in order to get repetition, but the words are different in the three groups on one page, and no two pages of any budget are the same. A maximum of three errors per page is allowed.

The following diagrams show the divisions of the keyboard for learning purposes, and the explanations indicate the nature of the work and the length of time spent on each of the six budgets.

BUDGET 1

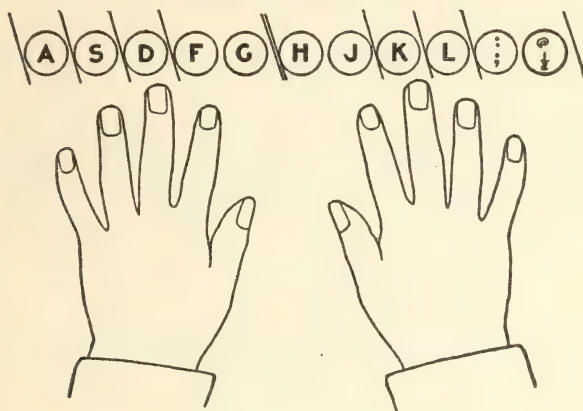


Figure I

FINGERING FOR BUDGET 1

The beginners first learned the keys of this row in pairs as follows:

Little fingers	A ;
Fingers next to the little fingers	S L
Big fingers	D K
Index fingers, not moving	F J
Index fingers, moving	G H

After the necessary instructions on mechanism, arrangement of words on a page, and demonstration of actual typewriting by the teacher, the learners started to typewrite for themselves the first page of Budget I. The first page is shown here in full, as the pages of all the budgets are arranged after this style, contain practically the same amount of work, and are the units of measurement used in these investigations of the work of beginners in typewriting.

Page 1 of Budget I

ad add sad fad fads lad lads salad salads glad gad had shad;
 ad add sad fad fads lad lads salad salads glad gad had shad;
 ad add sad fad fads lad lads salad salads glad gad had shad;
 ad add sad fad fads lad lads salad salads glad gad had shad;
 ad add sad fad fads lad lads salad salads glad gad had shad;

sag lag lags slag flag flags hag shag fag jag jags gag gags;
 sag lag lags slag flag flags hag shag fag jag jags gag gags;
 sag lag lags slag flag flags hag shag fag jag jags gag gags;
 sag lag lags slag flag flags hag shag fag jag jags gag gags;
 sag lag lags slag flag flags hag shag fag jag jags gag gags;

fag fags fad fads fall falls; flash flask flasks flag flags;
 fag fags fad fads fall falls; flash flask flasks flag flags;
 fag fags fad fads fall falls; flash flask flasks flag flags;
 fag fags fad fads fall falls; flash flask flasks flag flags;
 fag fags fad fads fall falls; flash flask flasks flag flags;

A maximum of three errors was allowed on each page in every budget. All the beginners continued their work on the different pages of this budget for a total of five hours, after which they all began the next budget together.

BUDGET 2

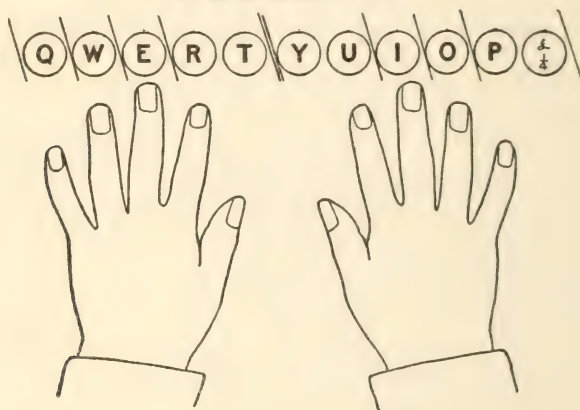


Figure II

FINGERING FOR BUDGET 2

The beginners next learned the keys of this row in pairs in this way:

Little fingers	Q	P
Fingers next to the little fingers	W	O
Big fingers	E	I
Index fingers, not moving	R	U
Index fingers, moving	T	Y

After a demonstration by the teacher, they started to typewrite for themselves the first page of Budget II, of which the following is a synopsis:

quit quitter quite quiet; quire quirt; queer query; quote quoit;
 pro prow prop proper property propriety pre prey pretty prettier
 titter twitter quitter utter putter wetter totter potter pottery

Each of these lines was repeated five times on the page. The students continued to work on the successive pages of this budget for a total of eight hours, and then all were ready for the next budget.

BUDGET 3



Figure III

FINGERING FOR BUDGET 3

The student next combined these two rows of keys, learning them downwards in pairs:

Little fingers	QA	P;
Fingers next to little fingers	WS	OL
Big fingers	ED	IK
Index fingers, not moving	RF	UJ
Index fingers, moving	TG	YH

After a demonstration by the teacher, they commenced work themselves on the first page of this budget, which repeats each line of the following five times:

swell tell dell sell fell; few dew hew strew; kettle fettle settle
 test west rest request; ledge hedge wedge sedge; lower dower tower
 deed feed seed weed reed; eel reel feel heel; setter letter fetter

After spending altogether seven hours working on the different pages of this budget, the learners attacked the next budget.

BUDGET 4



Figure IV

FINGERING FOR BUDGET 4

In this budget all the keys to be taken by one finger in the three rows were grouped together vertically, and the groups associated with similar fingers on the two hands were learned in pairs; for example:

Little fingers	QAZ	P; $\frac{3}{4}$
Fingers next to the little fingers	WSX	OL.
Big fingers	EDC	IK,
Index fingers, not moving	RFT	UJM
Index fingers, moving	TGB	YHN

When the teacher had demonstrated the use of these three rows, the pupils spent a total of five hours on the different pages of this budget. The following three lines formed the copy to be repeated five times each for the first page:

net nettle new need nay nail nature nip nipper night not note now
 ten often pen den fen hen win tin sin fin din wan ran tan pan fan
 can cant candle cede certain cellar city cite cigar cold coke cue

BUDGET 5

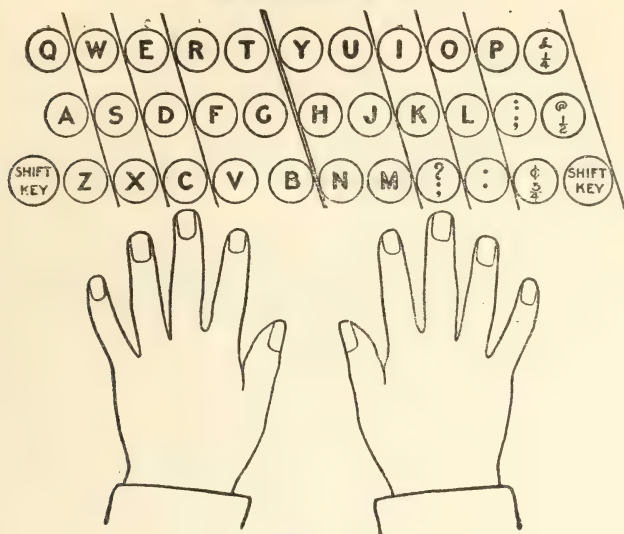


Figure V

FINGERING FOR BUDGET 5

The pupils learned from explanation and demonstration how to use the shift keys to make capitals. In this budget every word to be typed began with a capital. Five hours were spent altogether on this budget, of which the following three lines, to be repeated five times each, formed the copy for the first page:

An Up As Is So In By My Do No At Of Go He To If Re Us We It Be
 A Our Such Part That Many With Pull Sure Under Refer Make Care
 I For How Send Much Best Just Begin Place Sincere Precise Even

BUDGET 6

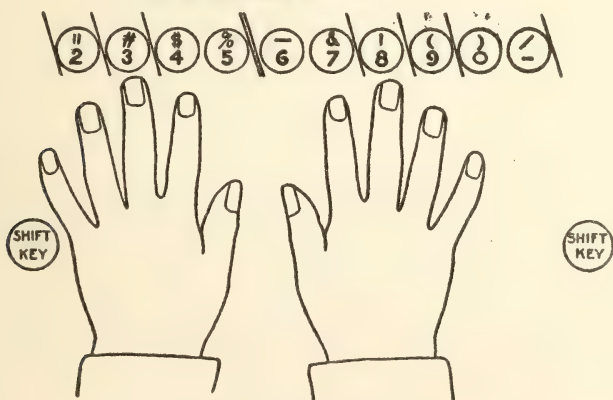


Figure VI

FINGERING FOR BUDGET 6

The learners next studied the figures of the top row by themselves, and then the signs by themselves, associating the keys in pairs to correspond with similar fingers on both hands. A total of five hours was spent on the different pages of this budget, after demonstration by the teacher. The following lines, to be repeated five times each, provided the copy for the first page, and show the plan on which the other pages were constructed in order to get practice on the different characters of this row:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
 \$24 \$25 \$26 \$27 \$28 \$29 \$30 \$31 \$32 \$33 \$34 \$35 \$36 \$37 \$38
 #39 #40 #41 #42 #43 #44 #45 #46 #47 #48 #49 #50 #51 #52 #53

In order to investigate the influence of practice in piano playing on improbability of beginners in typewriting, the plan that was taken was first to find out all the beginners in typewriting who had ever taken piano lessons, and to set down this information opposite the names of these students in the class lists. Then the first one hundred names of girls who had taken piano lessons were selected and placed together in one list, and the first one hundred names of girls who had never taken piano lessons were chosen and placed together in another list. All the students involved in the investigation were girls, so that any difference from sex ability was eliminated. The initial scholarship qualifications of the learners were all equal; the girls were all regular in attendance; none of them had any previous knowledge of typewriting; and, as ages were not used in selection of the learners, the average ages for the two groups were for our purpose the same. Thus the selection of the names from the class registers in alphabetical order could not have any bearing on typewriting ability, and the only condition that was different in the two groups was that of having had or not having had practice in playing a piano.

All the classes for beginners in typewriting, including these girls, started in September and worked till the Christmas vacation on the elementary course in touch typewriting as described above. Thirty minutes were spent in actual typewriting daily for seventy days, making a total of thirty-five hours of practice. All the machines used were No. 5 Underwood typewriters, with universal Canadian keyboards from which the printed characters had been removed and blanks substituted underneath the glass on the tops of the keys. The work of the pupils, dated and with mistakes marked, was turned in each day to the teacher for inspection, and, if satisfactory, was stamped approved, and recorded. At the end of the thirty-five hours of work an inventory was taken of the total achievement, and the total number of errors made by each learner in typewriting the pages he had done.

Table I shows the number of pages typed in thirty-five hours, and Table II the number of errors made while doing this work by the one hundred girls who had never taken piano lessons. Tables III and IV, respectively, show the total pages typed and total errors made during thirty-five hours by the one hundred girls who had taken piano lessons.

TABLE I

Scores of 100 Non-Piano Students for 35 Hours

Non-Piano Student	Hours of Practice							Total Pages	Non-Piano Student	Hours of Practice							Total Pages
	5	10	15	20	25	30	35			5	10	15	20	25	30	35	
1 E.A.	0	2	1	0	2	3	4	12	51 S.C.	0	2	3	5	4	4	3	21
2 V.B.	1	3	4	2	3	6	4	23	52 M.C.	1	2	6	2	6	8	7	32
3 M.B.	1	2	5	2	3	2	1	16	53 E.E.	1	4	4	4	7	7	4	31
4 E.D.	0	2	6	3	5	5	5	26	54 B.E.	1	4	4	4	9	8	4	34
5 L.D.	2	3	4	7	4	9	6	35	55 J.H.	2	1	5	3	6	8	6	31
6 E.E.	1	3	5	6	6	7	4	32	56 M.H.	0	1	2	2	6	3	3	17
7 M.E.	0	3	4	2	4	8	5	26	57 M.M.	1	3	8	6	7	8	3	36
8 F.F.	2	3	3	7	5	5	5	30	58 K.M.	6	14	7	9	7	14	8	65
9 I.H.	2	5	6	8	4	7	4	36	59 S.N.	2	6	11	7	6	13	5	50
10 D.H.	3	3	4	6	6	5	5	32	60 M.O.	4	7	8	4	5	8	3	39
11 M.H.	4	3	4	6	3	9	5	34	61 T.O.	1	5	4	5	3	9	6	33
12 J.L.	2	5	6	3	8	5	7	36	62 G.R.	0	6	4	4	5	10	4	33
13 D.L.	1	3	3	5	6	5	4	27	63 M.S.	1	3	4	4	5	3	2	22
14 W.M.	0	2	1	3	4	5	5	20	64 O.S.	1	4	3	4	4	5	4	25
15 F.M.	2	3	3	4	6	8	6	32	65 E.S.	0	5	7	8	4	7	4	35
16 E.M.	1	2	3	6	5	3	6	26	66 M.S.	2	2	2	3	4	9	3	25
17 H.S.	0	3	0	2	3	3	2	13	67 L.T.	2	2	4	5	5	6	6	30
18 C.S.	1	3	3	7	4	4	3	25	68 I.T.	0	2	4	5	5	3	2	21
19 C.S.	2	3	5	6	6	6	4	32	69 M.W.	1	3	1	2	5	3	2	17
20 P.T.	2	2	4	4	5	9	5	31	70 A.R.	2	3	3	4	4	5	6	27
21 A.T.	1	3	4	6	5	5	3	27	71 E.W.	1	4	6	7	8	9	3	38
22 D.T.	3	4	6	7	5	6	5	36	72 A.B.	4	9	11	11	11	10	6	62
23 M.T.	1	3	5	4	5	6	4	28	73 H.C.	2	4	6	5	6	7	3	33
24 I.T.	0	3	9	1	4	4	4	25	74 B.C.	0	3	3	4	4	5	5	24
25 E.W.	2	3	4	4	6	6	4	29	75 B.G.	0	4	7	4	4	7	4	30
26 M.H.	0	2	2	2	2	4	2	14	76 V.B.	0	3	7	1	4	5	5	25
27 V.H.	0	4	4	3	4	7	4	26	77 C.C.	0	2	4	5	5	4	3	23
28 H.H.	1	2	3	3	4	7	3	23	78 H.D.	1	8	2	6	6	6	4	33
29 H.H.	2	4	6	3	5	5	5	30	79 B.G.	2	3	6	3	3	5	5	27
30 B.J.	1	3	5	5	3	3	5	25	80 M.M.	0	3	2	1	6	5	2	19
31 E.R.	2	4	6	4	5	4	2	27	81 A.T.	1	4	7	4	4	7	3	30
32 E.W.	2	4	5	5	4	4	2	26	82 L.R.	0	2	3	4	4	2	4	19
33 A.B.	2	5	5	6	6	5	3	32	83 A.A.	2	3	5	6	7	5	4	32
34 P.B.	2	1	6	2	6	7	6	30	84 I.C.	3	5	4	3	4	5	7	31
35 M.C.	2	1	6	5	5	9	5	33	85 M.D.	1	5	5	5	9	10	3	38
36 D.C.	1	6	7	6	5	10	5	40	86 D.G.	0	3	1	4	5	6	3	22
37 G.D.	1	3	1	3	3	3	4	18	87 M.G.	2	1	6	3	6	7	5	30
38 W.E.	0	2	3	3	2	3	2	15	88 D.G.	2	4	4	3	4	9	5	31
39 P.G.	3	2	2	1	3	2	2	15	89 R.G.	1	3	3	4	5	3	3	22
40 R.G.	0	2	5	3	5	5	6	26	90 B.H.	0	1	2	1	4	6	5	19
41 E.H.	2	3	4	5	7	5	3	29	91 M.J.	0	4	4	5	5	7	3	28
42 G.J.	0	3	5	3	5	6	3	25	92 K.M.	1	2	7	4	4	6	4	23
43 K.N.	2	1	3	2	3	2	1	14	93 E.P.	2	5	5	7	6	7	6	38
44 E.S.	1	3	4	5	2	2	4	21	94 A.R.	0	5	6	6	7	9	4	37
45 M.A.	0	3	4	4	4	3	4	22	95 N.S.	3	4	5	4	5	6	5	32
46 M.B.	0	3	2	3	6	4	3	21	96 A.T.	0	2	3	3	4	6	5	23
47 V.B.	1	2	4	3	6	6	6	28	97 A.T.	1	4	3	3	5	7	4	28
48 G.B.	0	5	5	3	6	6	5	30	98 E.C.	1	3	3	3	4	7	3	24
49 G.C.	1	3	7	4	8	7	4	34	99 T.C.	1	2	4	4	5	10	4	30
50 M.C.	0	7	5	5	6	7	5	35	100 M.G.	0	2	4	5	4	6	3	24

Totals 119 338 444 420 497 602 412 2,832

TABLE II

Errors of 100 Non-Piano Students for 35 Hours

Non-Piano Student	Hours of Practice							Total Errors	Non-Piano Student	Hours of Practice							Total Errors
	5	10	15	20	25	30	35			5	10	15	20	25	30	35	
1 E.A.	0	3	0	0	3	9	9	24	51 S.C.	0	5	5	9	8	8	9	44
2 V.B.	6	7	5	7	5	6	6	42	52 M.C.	1	4	8	4	8	8	6	39
3 M.B.	3	5	11	3	7	5	2	36	53 E.E.	1	4	6	10	9	16	11	57
4 E.D.	0	5	10	3	10	13	6	47	54 B.E.	3	4	6	2	5	11	11	42
5 L.D.	3	4	3	3	5	20	6	44	55 J.H.	5	2	12	6	9	15	11	60
6 E.E.	3	6	7	9	8	10	7	50	56 M.H.	0	2	5	3	11	4	4	29
7 M.E.	0	7	8	4	12	16	12	59	57 M.M.	2	4	9	8	8	16	5	52
8 F.F.	3	5	6	14	12	6	7	53	58 K.M.	4	0	13	14	0	12	14	57
9 I.H.	0	5	4	6	4	6	4	29	59 S.N.	4	3	14	8	5	16	12	62
10 D.H.	5	4	7	10	10	8	8	52	60 M.O.	5	6	7	9	4	12	6	49
11 M.H.	7	4	7	7	5	13	10	53	61 T.O.	2	7	9	11	3	15	12	59
12 J.L.	4	1	8	5	9	11	10	48	62 G.R.	0	4	8	9	10	12	11	54
13 D.L.	3	3	12	4	9	8	9	48	63 M.S.	3	6	8	7	9	6	4	43
14 W.M.	0	4	3	8	5	9	11	40	64 O.S.	3	5	5	10	8	8	10	49
15 F.M.	6	5	5	7	9	11	9	52	65 E.S.	0	3	12	7	6	16	9	53
16 E.M.	1	6	5	12	8	12	6	50	66 M.S.	3	1	6	5	9	15	5	44
17 H.S.	0	8	0	4	9	5	5	31	67 L.T.	2	2	3	11	10	10	7	45
18 C.S.	2	6	5	13	9	8	9	52	68 I.T.	0	6	8	10	9	5	5	43
19 C.S.	4	5	9	7	6	11	5	47	69 M.W.	2	6	2	6	8	7	3	34
20 P.T.	3	2	5	4	5	11	10	40	70 A.R.	3	4	3	5	4	10	12	41
21 A.T.	3	5	7	6	7	7	5	40	71 E.W.	2	5	12	8	9	13	8	57
22 D.T.	0	5	12	6	7	13	8	51	72 A.B.	8	1	8	4	1	7	11	40
23 M.T.	0	6	8	3	6	10	6	39	73 H.C.	5	6	9	8	11	8	4	51
24 I.T.	0	7	6	0	3	3	6	25	74 B.C.	0	4	4	9	8	14	13	52
25 E.W.	3	1	6	5	12	12	7	46	75 B.G.	0	9	12	5	11	12	9	58
26 M.H.	0	4	4	4	2	15	6	35	76 V.B.	0	8	13	2	12	11	13	59
27 V.H.	0	5	4	3	10	14	8	44	77 C.C.	0	6	8	8	9	6	8	45
28 H.H.	2	3	5	8	6	13	8	45	78 H.D.	0	5	3	12	4	9	3	36
29 H.H.	1	6	12	1	10	10	9	49	79 B.G.	3	5	6	5	4	7	11	41
30 B.J.	3	5	8	6	8	7	12	49	80 M.M.	0	8	1	1	9	11	6	36
31 E.R.	4	2	9	4	10	9	6	44	81 A.T.	3	4	9	11	7	16	7	57
32 E.W.	4	7	10	12	11	7	6	57	82 L.R.	0	6	5	8	11	5	9	44
33 A.B.	6	8	7	10	9	6	4	50	83 A.A.	5	5	8	10	11	7	6	52
34 P.B.	3	3	8	3	9	7	10	43	84 I.C.	8	7	11	0	7	7	18	58
35 M.C.	2	2	8	4	7	6	10	39	85 M.D.	0	5	7	5	5	10	8	40
36 D.C.	3	4	6	6	3	3	6	31	86 D.G.	0	4	2	9	11	15	3	44
37 G.D.	3	4	3	7	9	6	8	40	87 M.G.	0	2	5	0	5	6	10	28
38 W.E.	0	9	5	6	5	7	5	37	88 D.G.	5	6	7	5	10	9	9	51
39 P.G.	4	0	5	4	5	5	4	27	89 R.G.	3	5	6	7	8	5	6	40
40 R.G.	0	6	7	9	9	1	10	42	90 B.H.	0	1	4	1	8	10	12	36
41 E.H.	6	4	6	8	10	7	5	46	91 M.J.	0	6	7	11	7	8	8	47
42 G.J.	0	5	9	2	8	7	4	35	92 K.M.	3	3	9	4	4	10	4	37
43 K.N.	3	2	7	5	5	6	3	31	93 E.P.	2	6	4	7	6	7	5	37
44 E.S.	0	6	4	10	4	4	6	34	94 A.R.	0	2	7	5	6	14	4	38
45 M.A.	0	4	0	10	8	6	7	35	95 N.S.	8	3	11	2	9	10	9	52
46 M.B.	0	6	6	8	10	11	7	48	96 A.T.	0	6	6	6	8	11	10	47
47 V.B.	3	3	7	7	14	11	14	59	97 A.T.	2	4	7	3	4	10	8	38
48 G.B.	0	6	6	5	11	12	9	49	98 E.C.	3	6	7	5	8	17	6	52
49 G.C.	3	5	8	4	6	14	9	49	99 T.C.	2	4	10	7	10	11	6	50
50 M.C.	0	5	9	2	6	10	10	42	100 M.G.	0	4	9	10	11	11	8	53

Totals..... 215 455 688 632 758 965 778 4,490

TABLE III

Scores of 100 Piano Students for 35 Hours

Piano Student	Hours of Practice							Total Pages		Piano Student	Hours of Practice							Total Pages
	5	10	15	20	25	30	35				5	10	15	20	25	30	35	
1 M.M.	0	1	2	0	1	5	2	11		51 W.M.	2	6	9	8	7	11	8	51
2 P.B.	1	10	12	6	11	13	8	61		52 V.P.	1	9	7	7	7	8	3	42
3 V.D.	0	6	5	6	5	9	4	35		53 G.Q.	0	8	7	7	8	7	4	41
4 M.L.	0	1	3	3	5	5	2	19		54 M.W.	2	9	10	6	6	12	5	50
5 E.S.	0	4	3	6	5	6	3	27		55 D.W.	2	6	8	4	6	9	4	39
6 H.Y.	2	11	11	11	7	14	7	63		56 E.W.	0	5	2	1	3	4	1	16
7 H.B.	2	5	6	3	6	7	6	35		57 I.B.	2	5	6	9	8	9	5	44
8 E.P.	0	2	3	1	7	9	5	27		58 E.B.	1	3	2	1	5	4	3	19
9 E.B.	1	2	3	6	5	6	5	28		59 V.B.	0	3	2	3	2	4	4	18
10 C.H.	0	4	2	3	5	2	2	18		60 J.C.	2	1	3	5	4	8	2	25
11 A.H.	0	3	1	3	2	3	3	15		61 G.F.	1	2	2	4	3	5	1	18
12 M.L.	0	3	1	6	3	6	4	23		62 R.F.	3	4	3	5	3	5	3	26
13 T.M.	0	4	2	3	6	2	9	26		63 L.G.	2	9	7	9	7	10	6	50
14 P.P.	1	3	5	2	5	6	4	26		64 J.P.	0	3	1	5	3	2	4	18
15 E.R.	3	0	3	3	3	1	1	14		65 A.H.	0	4	3	3	5	7	4	26
16 I.S.	0	4	2	4	4	2	6	22		66 M.H.	1	3	6	2	4	6	4	26
17 J.A.	0	4	5	2	1	3	2	17		67 D.I.	0	3	2	3	4	1	2	15
18 K.B.	2	5	5	3	6	2	7	30		68 M.K.	0	3	2	1	2	5	4	17
19 A.C.	2	3	2	3	4	6	3	23		69 R.L.	0	3	5	3	3	5	3	22
20 W.C.	3	5	3	4	5	6	5	31		70 J.L.	1	2	3	5	2	6	5	24
21 I.D.	0	6	5	5	9	10	3	38		71 R.W.	0	3	4	5	6	3	3	24
22 J.D.	0	1	7	5	3	6	3	25		72 N.R.	3	6	9	6	8	12	8	52
23 M.D.	0	3	8	3	4	3	4	25		73 D.W.	3	11	7	6	4	7	4	42
24 E.D.	1	2	4	2	5	4	2	20		74 M.T.	7	5	4	9	4	5	5	39
25 K.F.	3	4	2	4	7	10	3	33		75 H.H.	2	3	5	3	5	6	4	28
26 L.K.	2	5	8	5	6	9	4	39		76 R.A.	2	4	3	6	7	8	4	34
27 D.A.	0	3	2	4	4	4	2	19		77 N.A.	0	2	2	6	7	6	4	27
28 I.L.	4	3	4	4	5	9	7	36		78 A.B.	0	4	3	4	6	7	5	29
29 D.M.	2	5	5	4	5	5	3	29		79 F.B.	0	5	8	5	7	8	4	37
30 E.P.	1	2	2	1	3	4	2	15		80 P.N.	0	4	3	5	5	4	6	27
31 I.S.	3	7	6	4	8	6	4	38		81 R.W.	0	7	3	3	7	8	3	31
32 D.G.	3	3	5	4	6	4	3	28		82 B.N.	0	5	6	6	4	6	4	31
33 L.V.	3	0	6	2	6	7	5	29		83 I.N.	0	4	4	3	7	6	5	29
34 I.W.	1	5	8	6	7	9	6	42		84 M.S.	0	5	3	3	6	8	5	34
35 J.A.	3	8	9	7	6	9	6	48		85 D.S.	0	4	6	7	7	10	7	41
36 G.B.	1	11	8	10	10	11	9	60		86 C.T.	0	1	5	6	6	10	3	31
37 E.B.	1	9	6	4	9	9	6	44		87 M.T.	4	4	3	6	4	7	3	31
38 M.C.	0	4	4	6	5	4	4	27		88 E.T.	1	4	4	7	6	4	5	31
39 K.C.	4	17	12	12	11	15	8	79		89 V.D.	0	3	6	3	1	3	4	20
40 N.D.	0	4	7	6	6	9	5	37		90 E.B.	1	2	7	8	6	9	4	37
41 N.F.	1	8	8	2	6	5	5	35		91 J.B.	2	7	10	11	5	13	7	55
42 K.G.	2	12	13	13	8	13	5	66		92 D.C.	0	3	3	5	4	2	4	21
43 N.G.	0	10	8	8	9	14	10	59		93 W.G.	0	3	4	5	4	5	2	23
44 M.H.	1	6	4	4	5	9	6	35		94 M.R.	0	4	1	4	5	3	3	20
45 F.H.	0	3	5	1	6	3	3	21		95 D.K.	1	7	7	6	5	7	5	38
46 A.H.	0	7	6	4	4	6	5	32		96 M.P.	9	7	9	6	5	7	9	52
47 M.W.	3	5	3	3	2	3	3	22		97 E.P.	0	6	7	4	6	5	3	31
48 M.K.	6	10	8	6	6	9	5	50		98 M.P.	0	5	1	0	3	4	4	17
49 C.K.	2	8	8	7	4	10	6	45		99 E.P.	2	11	8	11	6	9	6	53
50 C.K.	0	6	1	5	6	3	3	24		100 A.P.	1	3	5	3	6	2	3	23

Totals. 122 490 501 482 531 557 439 3,222

In order to make use of the material in Tables I and III for the purpose of drawing the learning curves, the first quartiles, medians, and third quartiles were found for the pages typed in each period of five hours. These are shown in Tables V and VI.

TABLE V

Median and Quartiles from Table I

Hours practised	5	10	15	20	25	30	35
First quartile.....	.8	2.8	3.7	3.4	4.4	4.0	3.6
Median.....	1.6	3.6	4.7	4.5	5.3	6.4	4.6
Third quartile.....	2.4	4.6	6.1	5.9	6.4	7.9	5.6

TABLE VI

Median and Quartiles from Table III

Hours practised	5	10	15	20	25	30	35
First quartile.....	.5	3.5	3.2	3.6	4.5	4.6	3.6
Median.....	1.2	4.7	5.2	4.0	5.9	6.7	4.6
Third quartile.....	2.6	6.8	7.6	6.6	7.0	9.4	5.9

The criticism may be offered that, say in Table I, there are thirty-two students who did not complete a page during the first five hours of practice, and that these were apparently given a score of zero, whereas some credit should be given for the amount done, however small. The reply is that the score of zero in the tables is not absolute zero, but represents the interval between absolute zero and .9 of a page, which is the greatest amount of work that would be given the score of zero. In the same way a score of 1 represents the interval between exactly 1 and 1.9, while 2 represents the interval between exactly 2 and 2.9. In taking the first quartile for the one hundred students as 25/32 of 1 page, credit is assumed for scores ranging by normal distribution from absolute zero up to .9 of a page. Thus no injustice is caused by assigning a nominal zero score to these students, since the first quartile, .8 of a page and not zero pages, is used in drawing the learning curve. Also in any comparison of Tables I and III, since the nominal zero scoring is adopted in both, the ratio of total pages is the same as if fractions of pages were recorded in each table.

The figures given in Tables V and VI cannot be used directly as a basis for drawing the first quartile, median, and third quartile learning curves, for the reason that the budget pages vary in difficulty among themselves, and so vary as a standard of measurement of work. In order to overcome this difficulty, their values were weighted according to the following plan.

Ten expert typists, who were perfectly familiar with all the characters on the keyboard and to whom the copy was unfamiliar, were timed to the second by a stop watch while typing each page in every budget. Their individual scores were recorded and the average time for each separate page was calculated as shown in the columns of Table VII. Then, as the individual pages of any one budget appeared from the time taken to be of approximately the same difficulty, the average time for the group of pages constituting one budget was calculated as shown at the bottom of Table VII. The relativity or time ratio for the pages of one budget as compared with another was next found by dividing through by 2.4 minutes, which is the shortest time taken for the pages of any budget.

TABLE VII

Showing the average time in minutes taken by 10 experts to type budget pages.

Budget	I	II	III	IV	V	VI
Page 1.....	2.1	3.6	3.5	3.6	4.5	5.7
Page 2.....	2.3	3.3	3.4	3.5	4.1	5.6
Page 3.....	2.7	3.4	3.5	3.9	4.0	5.8
Page 4.....	....	3.2	3.3	3.6	....	....
Page 5.....	....	3.3	3.1	3.7	....	....
Page 6.....	....	3.3	3.3	3.9	....	....
Average.....	2.4	3.4	3.4	3.7	4.2	5.7
Relativity.....	1	1.4	1.4	1.5	1.8	2.4

These figures of relativity or time ratio are really indexes of the difficulty of the pages of each budget, as compared with the pages of Budget 1, which is taken as the standard of difficulty. Since the actual number of pages typed varies inversely as the difficulty, these figures were used to weight the first quartiles, medians, and third quartiles in Tables V and VI, thus transposing the actual achievement in all budgets subsequent to Budget 1 into proportionate terms of Budget 1.

The figures in Tables V and VI for the interval ending with the 5th hour would remain as they are, since the students worked on Budget 1 for the first five hours. The figures for the intervals ending with the 10th, 15th, and 20th hours were multiplied by the index 1.4, since the students worked for fifteen hours on Budgets II and III, which are of equal difficulty. The figures for the interval ending with the 25th hour were multiplied by the index 1.5, those for the interval ending with the 30th hour by the index 1.8, and those for the interval ending with the 35th hour by the index 2.4, on account of the increased difficulty of Budgets IV, V, and VI, respectively, which were typed during these periods. These weighted achievements are given in Tables VIII and IX, and are used as a basis for the learning curves in Figures VII, VIII and IX.

TABLE VIII

Showing weighted achievements of 100 non-piano-playing girls. Compiled from Tables V and VII.

Hours practised	5	10	15	20	25	30	35
First quartile.....	.8	3.9	5.2	4.8	6.6	7.2	8.6
Median.....	1.6	5.0	6.6	6.3	8.0	11.5	11.0
Third quartile.....	2.4	6.4	8.5	8.3	9.6	14.2	13.4

TABLE IX

Showing weighted achievements of 100 piano-playing girls. Compiled from Tables VI and VII.

Hours practised	5	10	15	20	25	30	35
First quartile.....	.5	4.9	4.5	5.0	6.8	8.3	8.6
Median.....	1.2	6.6	7.3	5.6	8.9	12.1	11.0
Third quartile.....	2.6	9.5	10.6	9.2	14.4	16.9	14.2

FIGURE VII

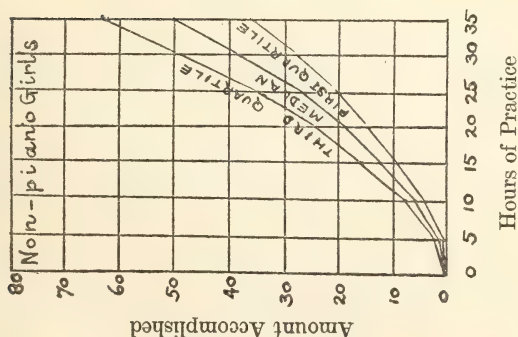


FIGURE VIII

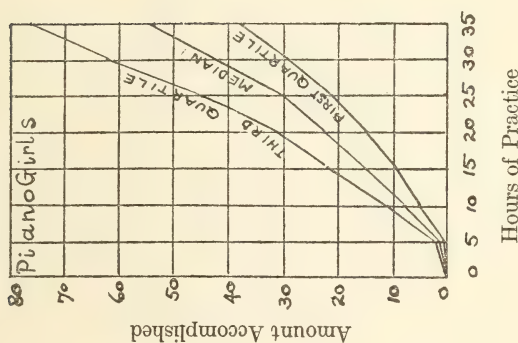


FIGURE IX

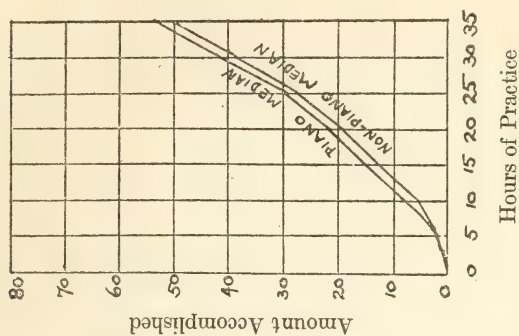


Figure VII shows the first quartile (lowest curve), median (middle curve), and third quartile (highest position) improvement curves in typewriting for one hundred non-piano-playing girls during the first thirty-five hours of practice.

Figure VIII shows similar curves for one hundred piano-playing girls.

Figure IX compares the median curves for the two groups, the upper one being for piano-playing girls and the lower one for non-piano-playing girls.

The thirty-five hours of practice studied in the preceding statistics extended from September to Christmas. Between Christmas and June it was again possible to follow the improvement in typewriting of the same students, since they all continued at school throughout that school year. This period was largely taken up in practice for the acquisition of speed, and extended over twenty weeks, with one half-hour of actual typewriting per day, making a total of one hundred lessons, or fifty hours' practice. The method of studying the improvement in typewriting during these fifty hours was as follows:

Once a week throughout the fifty hours the speed of the pupils in typewriting was tested by a five-minute test. In preparation for this work the pupils were given full information regarding the purpose and method of conducting these tests. They knew that the object was to measure the improvement of their typewriting, and that each week they would be given a printed copy in large type from which to typewrite new matter in English. They knew they were to typewrite as much of this material as possible during the five minutes, and that they would be penalized to the extent of one word off for each error made. They were aware that the mark for passing in typewriting depended on reaching a speed of thirty net words per minute on one of these tests; so they exerted themselves to the utmost of their capacity. In order to get the maximum score, they had to decide individually whether the best plan was to strive for great speed regardless of how many errors were made, or whether better final results would be reached by slower typing without making many mistakes.

The practice matter for these five-minute tests consisted of material that was specially composed for typewriting speed tests, and was supplied by the Underwood Typewriter Company, of New York City. The author of the selections, J. N. Kimball, has a wide reputation as manager of the International World's Championship Typewriting Contests, held yearly in New York. In composing the test matter he says he tries to have the words average out to five strokes each, and thus have the tests of approximately equal difficulty. Having received these tests monthly for ten or twelve years past, I had such a collection of them that it was possible to select tests that were uniformly easy, and free from long words and difficult punctuation. The following samples are the first one hundred words of three of the tests that were used, and by actual count average 4.26, 4.34 and 4.37 strokes respectively per word:

- (1) "Of course I left that knoll, there is no need to say it, and pushed on again through the same old scrub. By and by I came to a flat rock as large and as level as the floor of my office, and covered with soft moss. It was dry and clean and the idea came to me that it would be a good place for me to make a camp and pass the night. I had a lot of matches and some of them were dry and I also had a few trout which I could cook for my . . ."
- (2) "I suppose it is a fable, that old story of Milo, the Greek, which tells us how he was bullied and badgered into trying to lift an ox and did not have any luck at it; in fact the ox went on chewing its cud and switching its tail in the belief that Milo was only a new kind of fly. But the Greek was a crafty chap;

he knew two or three things which it would be well for all of us to know, and one of them was that many a little makes a much; and . . .”

- (3) “I left school to go to work as a civil engineer—at least that is what they called me, and I was not a little proud of the title—but I know now that if it had been uncivil it would have hit closer to the mark. My first essay at it was to pull the front end of an iron chain over the crust of the earth with one hand and carry in the other a lot of long iron pins with little red flags on them. When the man at the hind end of the chain, who for . . .”

The test papers printed in large type were given to all the classes on the same day of every week, and all printed and typewritten papers were collected at the end of the lesson period, so there was no communication of the copy from class to class before the tests. The copy was new and unfamiliar to all, and had not been seen or practised by the pupils previous to the tests. The percentage of students who had access to typewriters outside of school was found to be negligible; so the practice received in school was really the only practice received by the pupils between tests. After each test the pupils marked their own work so as to show the following: (1) gross number of words typed in the five minutes; (2) number of mistakes in words, punctuation, or spacing, not more than one error being counted in any word; (3) net score on the basis of one point for each word attempted, less a penalty of one point for each mistake. The papers were then collected by the teacher, re-checked, and the results recorded. The net results at intervals of ten hours are given in Table X for the one hundred non-piano-playing girls and in Table XI for the one hundred piano-playing girls, and are shown graphically in Figures X, XI and XII.

FIGURE X

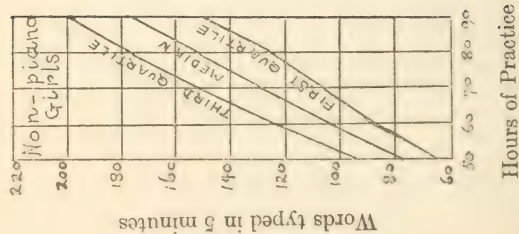


FIGURE XI

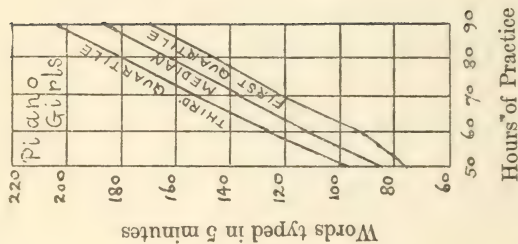


FIGURE XII

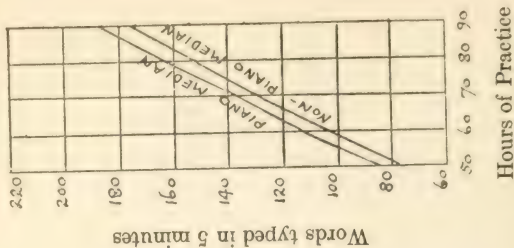


Figure X shows the lowest curve in the drawing, the median (middle curve), and third quartile (highest position) improvement curves in typewriting for one hundred non-piano-playing girls from the 50th to the 90th hour of practice.

Figure XI shows similar curves for one hundred piano-playing girls.

Figure XII compares the median curves for the two groups, the upper curve being for piano-playing girls and the lower curve for non-piano-playing girls.

TABLE X

Scores of 100 Non-Piano Students for Hours 50-90

Non-Piano Student	Hours of Practice					Non-Piano Student	Hours of Practice				
	50	60	70	80	90		50	60	70	80	90
1 E.A.	51	101	124	160	180	51 S.C.	50	62	85	112	150
2 V.B.	69	104	112	138	188	52 M.C.	111	134	169	184	215
3 M.B.	44	120	150	173	179	53 E.E.	123	151	188	231	247
4 E.D.	69	127	170	201	218	54 B.E.	120	142	189	235	256
5 L.D.	77	120	155	182	192	55 J.H.	65	95	127	138	156
6 E.E.	84	118	177	190	205	56 M.H.	55	85	108	126	160
7 M.E.	75	108	121	168	184	57 M.M.	101	129	172	183	195
8 F.F.	109	134	149	157	162	58 K.M.	103	136	163	186	202
9 I.H.	95	136	154	169	172	59 S.N.	94	127	151	173	194
10 D.H.	68	92	109	122	128	60 M.O.	83	116	142	157	177
11 M.H.	79	104	135	147	159	61 T.O.	65	99	116	135	155
12 J.L.	75	107	149	174	193	62 G.R.	89	117	144	151	191
13 D.L.	57	71	89	103	115	63 M.S.	61	92	103	115	125
14 W.M.	52	101	112	138	143	64 O.S.	74	91	119	162	179
15 F.M.	85	120	162	187	201	65 E.S.	63	78	107	128	155
16 E.M.	72	103	127	175	198	66 M.S.	66	90	101	124	151
17 H.S.	73	99	144	158	175	67 L.T.	77	102	159	170	193
18 C.S.	89	95	125	177	206	68 I.T.	63	94	102	109	141
19 C.S.	69	79	91	101	118	69 M.W.	62	106	134	145	155
20 P.T.	82	122	157	177	193	70 A.R.	52	63	76	101	140
21 A.T.	58	67	74	91	116	71 E.W.	103	134	152	194	216
22 D.T.	69	81	95	107	120	72 A.B.	100	178	203	224	222
23 M.T.	54	69	72	89	114	73 H.C.	65	79	89	117	127
24 I.T.	120	145	200	221	232	74 B.C.	62	99	146	160	168
25 E.W.	89	112	121	132	139	75 B.G.	109	141	158	188	206
26 M.H.	48	55	68	79	120	76 V.B.	71	99	125	175	197
27 V.H.	51	67	72	85	131	77 C.C.	84	102	123	161	195
28 H.H.	47	51	69	75	106	78 H.D.	88	129	152	178	209
29 H.H.	60	71	82	91	127	79 B.G.	71	86	114	143	192
30 B.J.	75	88	100	127	158	80 M.M.	62	81	95	129	162
31 E.R.	55	66	79	88	106	81 A.T.	104	114	151	194	225
32 E.W.	49	86	103	129	155	82 L.R.	99	122	153	158	190
33 A.B.	85	97	118	132	153	83 A.A.	84	115	142	159	194
34 P.B.	126	137	144	159	170	84 I.C.	94	116	142	183	195
35 M.C.	114	132	154	170	186	85 M.D.	104	127	178	220	233
36 D.C.	100	116	133	140	157	86 D.G.	77	94	108	131	146
37 G.D.	74	122	148	168	183	87 M.G.	104	130	157	184	199
38 W.E.	82	107	129	140	149	88 D.G.	108	125	152	176	197
39 P.G.	120	129	151	172	191	89 R.G.	97	121	137	154	193
40 R.G.	98	122	166	179	184	90 B.H.	45	60	72	110	141
41 E.H.	70	88	95	123	145	91 M.J.	79	96	133	151	190
42 G.J.	72	94	110	131	151	92 K.M.	79	93	114	140	158
43 K.N.	82	104	124	146	152	93 E.P.	71	87	134	145	182
44 E.S.	85	107	134	148	183	94 A.R.	117	134	161	181	214
45 M.A.	48	89	114	144	151	95 N.S.	60	89	117	141	160
46 M.B.	57	65	85	101	118	96 A.T.	51	58	87	121	150
47 V.B.	72	92	135	179	197	97 A.T.	65	90	120	147	166
48 G.B.	106	114	147	187	220	98 E.C.	62	76	92	109	134
49 G.C.	112	128	156	192	236	99 T.C.	75	98	125	144	166
50 M.C.	89	112	157	188	212	100 M.G.	51	60	82	94	115

First quartile.....
Median.....
Third quartile.....

63.2 87.0 105.6 126.6 150.6
76.0 102.7 129.2 151.1 175.0
93.3 123.1 152.9 177.1 197.0

TABLE XI

Scores of 100 Piano Students for Hours 50-90

Piano Student	Hours of Practice					Piano Student	Hours of Practice				
	50	60	70	80	90		50	60	70	80	90
1 M.M.	38	57	75	92	120	51 W.M.	86	128	164	177	189
2 P.B.	101	154	173	197	230	52 V.P.	101	117	162	190	207
3 V.D.	78	110	126	153	176	53 G.Q.	60	102	115	138	161
4 M.L.	74	113	128	160	206	54 M.W.	103	117	136	171	209
5 E.S.	103	123	160	182	203	55 D.W.	69	103	119	140	184
6 H.Y.	99	132	146	160	178	56 E.W.	58	95	118	130	149
7 H.B.	82	114	130	144	186	57 I.B.	114	136	153	179	193
8 E.P.	80	119	139	178	201	58 E.B.	86	119	136	154	164
9 E.B.	55	81	107	143	163	59 V.B.	75	87	103	136	152
10 C.H.	51	75	102	124	140	60 J.C.	87	105	142	163	173
11 A.H.	82	94	123	156	182	61 G.F.	68	95	112	132	149
12 M.L.	60	83	102	152	171	62 R.F.	76	94	124	143	152
13 T.M.	81	95	121	150	172	63 L.G.	94	133	145	173	198
14 P.P.	77	117	147	183	217	64 J.P.	91	109	138	149	157
15 E.R.	77	115	141	166	193	65 A.H.	66	85	102	146	170
16 I.S.	83	88	103	124	139	66 M.H.	98	117	135	171	187
17 J.A.	81	120	135	155	176	67 D.I.	75	113	135	149	162
18 K.B.	69	106	125	154	167	68 M.K.	81	110	122	145	151
19 A.C.	82	114	153	169	195	69 R.L.	81	116	140	155	171
20 W.C.	73	105	118	148	179	70 J.L.	82	105	143	154	166
21 I.D.	115	131	163	186	201	71 R.W.	85	111	131	135	152
22 J.D.	132	171	192	215	232	72 N.R.	107	121	141	177	194
23 M.D.	67	114	161	181	205	73 D.W.	113	131	164	166	179
24 E.D.	77	135	147	179	204	74 M.T.	93	117	133	152	184
25 K.F.	88	111	137	162	180	75 H.H.	81	100	126	162	176
26 L.K.	131	160	195	211	233	76 R.A.	80	115	125	166	202
27 D.A.	73	99	116	148	171	77 N.A.	93	128	147	191	233
28 I.L.	83	108	127	168	194	78 A.B.	69	107	125	149	191
29 D.M.	87	98	120	147	169	79 F.B.	117	152	164	200	233
30 E.P.	54	84	108	129	152	80 P.N.	82	116	135	170	188
31 I.S.	71	111	141	173	206	81 R.W.	102	125	142	164	173
32 D.S.	80	119	153	167	186	82 B.N.	84	119	149	162	190
33 L.V.	84	96	132	167	187	83 I.N.	71	86	101	126	162
34 I.W.	101	116	139	155	162	84 M.S.	84	124	182	225	221
35 J.A.	93	121	142	171	211	85 D.S.	113	153	172	222	250
36 G.B.	97	127	143	180	203	86 C.T.	72	115	146	167	185
37 E.B.	61	83	102	145	170	87 M.T.	84	95	127	163	182
38 M.C.	106	148	163	187	199	88 E.T.	94	117	127	151	160
39 K.C.	72	98	122	146	174	89 V.D.	73	99	114	120	152
40 N.D.	71	107	126	145	162	90 E.B.	82	138	207	222	224
41 N.F.	63	97	125	147	176	91 J.B.	131	188	209	238	230
42 K.G.	84	121	159	178	192	92 D.C.	76	142	179	211	226
43 N.G.	78	120	151	176	201	93 W.G.	62	88	152	190	199
44 M.H.	84	92	113	127	163	94 M.R.	40	106	147	149	154
45 F.H.	69	101	121	149	190	95 D.K.	112	167	201	229	236
46 A.H.	75	106	131	156	194	96 M.P.	126	159	171	212	235
47 M.W.	93	105	117	149	160	97 E.P.	104	112	144	162	188
48 M.K.	84	108	124	136	182	98 M.P.	77	92	117	129	166
49 C.K.	100	156	167	192	220	99 E.P.	114	153	199	220	238
50 C.K.	84	121	145	163	195	100 A.P.	74	158	181	207	204

First quartile.....

73.3 90.0 122.6 145.8 168.7

Median.....

83.7 113.3 137.3 162.2 185.0

Third quartile.....

96.0 125.8 153.3 178.5 203.1

TABLE XII
COMPARATIVE SUMMARY OF TABLES I, II, III AND IV

	Non- Piano Playing Beginners	Piano Playing Beginners	Gain Per Cent.
Total students examined.....	100	100	.....
Total hours of practice.....	35	35	.....
Total budget pages typed.....	2,832	3,222	13.73
Total errors made.....	4,490	4,272	5.09
Average pages per student.....	28.32	32.22	23.73
Average errors per student.....	44.90	42.72	5.09
Average errors per page.....	1.58	1.32	19.69

From a comparative study of the two groups of students, as shown in Tables I, III and XII, it is seen that the piano-playing beginners in typewriting as a group achieved more work than the non-piano-playing beginners (1) in total output during the whole period of thirty-five hours, and (2) in output of every interval of five hours during this period. It is seen from Tables II, IV and XII that the piano-playing students as a group were more accurate than the non-piano-playing students (1) by a smaller total of errors during the whole period, and (2) by having fewer errors during every interval of five hours, except the last five hours, when the piano-playing students had 1% more errors than the non-piano-playing students.

From Tables X and XI it is seen that during the period from the 40th to the 90th hour, when practising for speed also, the piano-playing girls as a group surpassed the non-piano-playing girls. While the best individuals in the non-piano-playing group made higher scores than the poorest in the piano-playing group, yet the highest individual scores also were made by the piano-playing students.

The conclusion would seem to be that the piano-playing students had previously learned from the technique of the piano certain positions, motions, and methods which they brought and applied, for the most part unconsciously, to the manipulation of the typewriter, and naturally surpassed the non-piano-playing students who had no such favourable habit conditions previously formed.

III.—INFLUENCE OF SEX

In order to investigate the learning of typewriting by girls, as compared with boys, during the beginners' period of the initial thirty-five hours' practice, the average of the weighted first quartiles, medians and third quartiles of the budget pages, done at intervals of five hours by the one hundred non-piano-playing girls and by the one hundred piano-playing girls, was found from Tables VIII and IX. These results are shown in Table XIII.

TABLE XIII

Weighted Median and Quartiles of 200 Girls for 35 Hours

Hours of practice	5	10	15	20	25	30	35
First quartile.....	.7	4.4	4.9	4.9	6.7	7.7	8.6
Median.....	1.4	5.8	7.0	6.0	8.5	11.8	11.0
Third quartile.....	2.5	8.0	9.6	8.8	12.0	15.6	13.8

Then the pages actually typed at intervals of five hours during the same period by one hundred boys were tabulated as shown in Table XIV, with the first quartiles, medians and third quartiles calculated. Using Table VII these measures were weighted and the results shown in Table XV. Tables XIII and XV are the basis for drawing the learning curves shown in Figures XIII, XIV and XV.

FIGURE XIII

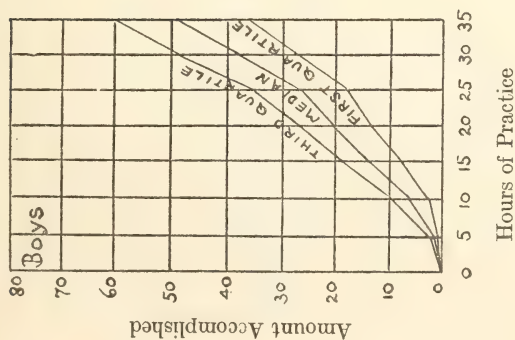


FIGURE XIV

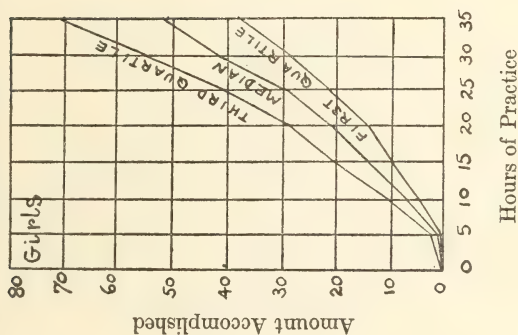


FIGURE XV

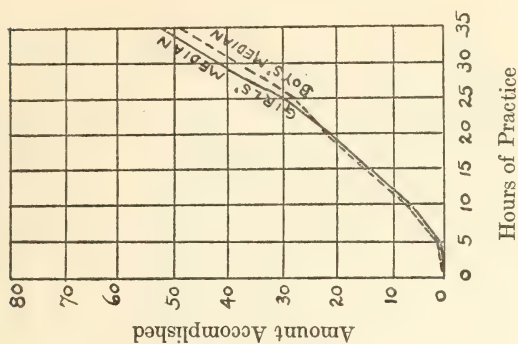


Figure XIII shows the first quartile (the lowest curve in the drawing), median (middle curve), and third quartile (highest position) improvement curves in typewriting for one hundred boys during the first thirty-five hours of the beginners' period.

Figure XIV shows similar curves for two hundred girls.

Figure XV compares the median curves for the two groups, the continuous line being for girls and the dotted line for boys.

TABLE XIV

Scores of 100 Boys for 35 Hours

Hours of Practice									Totals		Hours of Practice									Totals	
Boys	5	10	15	20	25	30	35		Pages	Errors	Boys	5	10	15	20	25	30	35		Pages	Errors
1 J.C.	2	6	4	6	5	7	6	36	49		51 B.T.	0	3	4	3	5	6	2	23	31	
2 R.S.	3	6	2	6	3	9	4	33	55		52 A.C.	1	6	5	4	3	6	4	30	42	
3 R.W.	1	4	8	4	4	1	0	22	24		53 W.A.	0	5	5	4	4	6	5	29	51	
4 B.A.	1	2	5	4	4	6	4	26	44		54 A.R.	0	4	5	4	1	1	2	17	41	
5 B.M.	3	7	4	0	2	8	4	28	42		55 A.T.	0	4	3	4	3	3	4	21	30	
6 E.R.	2	4	4	3	7	6	5	31	42		56 J.K.	0	3	3	5	4	5	4	24	30	
7 G.O.	4	4	6	3	6	8	5	36	21		57 W.D.	0	4	5	4	6	6	4	29	45	
8 B.M.	2	5	3	5	4	5	4	28	51		58 R.N.	3	2	3	2	3	5	2	20	30	
9 J.B.	2	1	5	2	3	2	2	17	30		59 J.H.	0	4	2	4	3	1	3	17	38	
10 H.B.	3	8	3	3	7	6	7	37	43		60 J.R.	3	5	3	4	4	6	4	29	48	
11 R.E.	1	4	6	4	6	6	3	30	38		61 A.M.	0	3	3	7	3	6	3	25	44	
12 A.P.	1	4	7	3	8	3	3	30	34		62 W.M.	0	3	5	8	2	5	3	26	42	
13 M.D.	3	4	4	6	6	11	4	37	33		63 A.T.	1	6	6	4	5	5	3	30	57	
14 G.L.	3	5	7	5	4	8	3	35	27		64 M.M.	0	4	1	1	7	4	2	19	36	
15 C.G.	1	3	1	3	3	3	2	16	36		65 B.G.	2	3	5	4	4	5	4	27	42	
16 G.C.	1	4	3	5	4	6	3	26	41		66 W.S.	3	3	4	5	3	5	5	28	48	
17 R.G.	1	4	4	6	7	6	6	34	29		67 R.P.	8	8	8	10	2	8	3	47	34	
18 J.L.	1	7	4	2	3	4	3	23	27		68 G.S.	6	8	4	4	4	6	4	36	64	
19 W.W.	6	9	5	5	6	9	3	43	44		69 J.G.	2	2	6	1	5	4	2	22	45	
20 A.C.	4	8	3	8	4	6	3	38	43		70 D.C.	4	4	7	3	1	8	4	32	34	
21 E.A.	2	3	4	4	2	6	2	23	45		71 R.L.	1	3	3	1	3	6	5	22	28	
22 D.F.	3	8	7	8	4	6	4	40	41		72 J.G.	4	8	4	4	5	7	2	34	57	
23 J.D.	3	3	6	5	5	7	2	31	41		73 C.B.	3	2	4	2	4	5	2	22	34	
24 W.D.	0	1	5	4	5	5	4	24	50		74 G.W.	1	3	4	6	4	7	5	30	54	
25 C.H.	1	6	7	7	9	13	4	47	50		75 C.A.	3	4	5	4	4	6	4	30	42	
26 G.C.	0	3	4	2	3	6	4	22	45		76 R.A.	3	2	4	8	4	5	4	30	48	
27 G.E.	2	2	4	5	2	6	3	24	39		77 A.R.	1	3	1	5	2	4	3	19	49	
28 V.L.	1	5	7	7	2	7	6	35	48		78 F.A.	1	5	2	5	2	1	2	18	26	
29 L.E.	0	5	7	7	2	7	4	32	52		79 E.N.	1	3	4	4	5	6	3	26	50	
30 G.B.	0	5	7	7	7	7	3	36	45		80 M.C.	1	2	5	2	3	2	1	16	37	
31 D.A.	1	3	7	7	4	9	4	35	37		81 F.E.	2	3	3	11	5	4	2	30	54	
32 G.T.	1	4	5	7	6	11	4	38	44		82 J.N.	3	5	5	3	8	7	5	36	48	
33 J.B.	1	4	6	8	8	7	5	39	40		83 D.A.	0	2	6	3	5	5	5	26	48	
34 H.M.	1	4	7	5	6	11	5	39	46		84 W.E.	2	3	5	3	6	7	3	29	46	
35 F.K.	2	2	6	8	5	9	5	37	45		85 W.M.	0	2	1	3	4	5	5	20	41	
36 A.J.	2	3	6	5	5	7	3	31	43		86 S.T.	0	3	5	4	4	6	3	25	36	
37 L.C.	0	4	2	8	3	9	4	31	45		87 N.T.	0	3	4	2	4	8	5	26	58	
38 L.M.	3	5	3	4	3	8	5	31	40		88 P.R.	2	2	4	4	5	9	5	31	44	
39 H.W.	1	4	6	5	4	6	4	30	29		89 M.K.	4	3	4	6	6	6	5	34	53	
40 A.R.	1	4	1	5	5	6	4	26	36		90 K.T.	1	4	3	4	4	5	4	25	52	
41 P.F.	3	2	3	4	4	3	3	22	45		91 I.B.	1	3	2	4	4	4	3	21	43	
42 K.C.	0	4	1	5	5	6	4	26	49		92 A.G.	2	4	4	2	2	4	1	19	32	
43 V.T.	2	1	4	2	5	6	3	24	51		93 V.S.	1	5	5	2	6	3	2	24	42	
44 W.C.	0	5	4	1	3	4	3	20	29		94 M.L.	1	2	3	3	5	5	2	21	43	
45 E.M.	0	3	6	3	5	5	4	26	44		95 E.S.	1	4	3	5	5	6	3	27	43	
46 A.K.	2	4	3	2	2	6	3	23	49		96 J.W.	0	3	2	3	2	2	2	14	29	
47 B.D.	0	3	4	5	3	6	4	25	53		97 H.J.	1	3	3	2	4	5	2	23	38	
48 H.B.	2	5	5	1	6	7	3	29	49		98 B.D.	1	3	3	4	5	8	5	29	42	
49 F.G.	1	4	5	5	5	6	4	29	52		99 A.N.	4	3	4	3	6	8	4	32	43	
50 R.S.	0	3	4	1	4	5	4	21	48		100 E.N.	1	2	3	5	4	5	5	25	57	
First quartile.....											1.0	1.3	3.7	3.4	3.6	5.3	3.2				
Median.....											1.8	4.2	4.7	4.6	4.7	6.4	4.1				
Third quartile.....											2.0	5.2	5.9	5.8	5.8	7.5	4.9				

TABLE XV

Weighted Median and Quartiles of 100 Boys for 35 Hours

Hours of practice	5	10	15	20	25	30	35
First quartile.....	1.0	1.8	5.2	4.8	5.4	9.5	7.7
Median.....	1.8	5.9	6.6	6.4	7.1	11.5	9.8
Third quartile.....	2.0	7.3	8.3	8.1	8.7	13.5	11.8

To compare the accuracy of the boys with that of the girls during the thirty-five hours' practice, the first quartiles, medians and third quartiles of the total pages actually typed and of the total errors made were found for the two hundred girls from Tables I, II, III, and IV, and for the boys from Table XIV. Then the average errors per page were calculated as shown in Table XVI.

TABLE XVI

Comparison of Work of Boys and Girls for 35 Hours

	Girls			Boys		
	Total Pages	Total Errors	Errors per Page	Total Pages	Total Errors	Errors per Page
First quartile.....	23.4	37.9	1.6	23.3	36.5	1.6
Median.....	29.4	44.3	1.5	28.3	43.4	1.5
Third quartile.....	35.6	51.3	1.4	33.6	48.6	1.4

The conclusion from the study of these curves and tables is that the girls as a group surpass the boys as a group in amount of work typewritten; but that the boys at some stages of the work are ahead of the girls; that the best individuals among the boys are the equal of the best individuals among the girls; and that boys and girls are exactly equal in percentage of accuracy during the first thirty-five hours of practice in the beginners' period.

TABLE XVII

Scores of 100 Boys for 50-90 Hours of Practice

Hours of Practice						Hours of Practice					
Boys	50	60	70	80	90	Boys	50	60	70	80	90
1 J.C.	81	117	124	154	174	51 B.T.	80	124	150	165	170
2 R.S.	104	127	163	183	194	52 A.C.	69	108	137	160	185
3 R.W.	75	118	131	167	187	53 W.A.	57	113	122	153	176
4 B.A.	93	110	120	142	158	54 A.R.	75	107	120	152	173
5 B.M.	62	111	137	148	153	55 A.T.	80	113	135	158	194
6 E.R.	79	114	130	144	167	56 J.K.	60	103	128	149	163
7 G.O.	85	119	128	139	161	57 W.D.	72	115	139	163	183
8 B.M.	92	121	138	159	169	58 R.N.	94	117	133	146	169
9 J.B.	72	110	133	168	179	59 J.H.	72	138	150	174	195
10 H.B.	95	102	129	154	185	60 J.R.	97	127	141	153	183
11 R.E.	82	123	161	182	198	61 A.M.	72	112	131	150	162
12 A.P.	69	99	121	142	158	62 W.M.	81	93	115	133	148
13 M.D.	77	102	129	141	160	63 A.T.	65	106	132	144	161
14 G.L.	52	99	118	129	151	64 M.M.	71	107	139	153	169
15 C.G.	94	117	132	148	169	75 B.G.	104	121	147	166	183
16 G.C.	123	157	176	195	200	66 W.S.	80	106	134	141	157
17 R.G.	62	99	123	142	167	67 R.P.	85	114	139	156	183
18 J.L.	95	124	159	171	176	68 G.S.	73	102	130	151	166
19 W.W.	73	142	177	199	207	69 J.G.	57	83	103	117	134
20 A.C.	80	119	136	154	163	70 D.C.	81	101	128	139	156
21 E.A.	162	189	206	257	281	71 R.L.	44	92	125	139	153
22 D.F.	64	118	133	162	192	72 J.G.	61	83	108	122	150
23 J.D.	69	125	160	181	212	73 C.B.	60	113	132	150	164
24 W.D.	97	116	136	161	173	74 G.W.	80	113	148	180	194
25 C.H.	73	101	127	137	159	75 C.A.	96	111	158	189	201
26 G.C.	95	113	137	161	185	76 R.A.	58	98	122	139	151
27 G.E.	97	102	126	147	162	77 A.R.	76	112	124	131	159
28 V.L.	69	89	95	103	115	78 F.A.	77	110	125	151	174
29 L.E.	117	135	147	167	189	79 E.N.	61	98	119	124	156
30 G.B.	91	105	131	158	176	80 M.C.	87	130	158	174	181
31 D.A.	81	93	115	133	148	81 F.E.	86	100	137	149	156
32 G.T.	57	113	123	147	177	82 J.N.	73	103	126	136	151
33 J.B.	71	117	146	169	185	83 D.A.	76	108	127	149	169
34 H.M.	92	129	142	156	176	84 W.E.	80	106	128	135	157
35 F.K.	116	135	150	194	220	85 W.M.	53	92	110	131	155
36 A.J.	112	126	158	197	201	86 S.T.	60	107	127	146	170
37 L.C.	95	121	162	190	214	87 N.T.	82	99	111	136	151
38 L.M.	72	110	133	152	168	88 P.R.	84	98	119	138	163
39 H.W.	85	111	120	149	163	89 M.K.	55	82	115	130	146
40 A.R.	75	107	120	149	156	90 K.T.	70	106	125	137	150
41 P.F.	89	112	134	151	169	91 I.B.	84	101	138	160	171
42 K.C.	64	97	120	160	180	92 A.G.	72	116	149	167	186
43 V.T.	104	116	125	130	156	93 V.S.	59	93	113	140	158
44 W.C.	67	98	112	128	151	94 M.L.	85	129	158	172	190
45 E.M.	68	98	116	136	162	95 E.S.	76	116	138	146	178
46 A.K.	73	140	162	199	206	96 J.W.	93	106	142	161	185
47 B.D.	81	119	128	147	168	97 H.J.	86	125	139	160	178
48 H.G.	69	113	138	159	182	98 B.D.	74	111	130	145	166
49 F.G.	81	121	154	188	200	99 A.N.	92	120	133	160	174
50 R.S.	99	118	150	166	181	100 E.N.	88	110	123	134	165
First quartile.....	69.8	102.7	123.8	140.5	159.1						
Median.....	75.0	112.5	132.3	152.1	169.6						
Third quartile.....	85.0	119.4	141.2	165.6	185.0						

The improvement in typewriting of these one hundred boys was studied further during the period from the 50th to the 90th hour by the same method as described in Chapter II, namely, by weekly five-minute tests. The results of these tests, at intervals of ten hours, are given in Table XVII, with the first quartile, median, and third quartile calculated for each interval. For each interval of ten hours of practice during the same period, the first quartile, median, and third quartile for one hundred non-piano-playing girls from Table X and for one hundred piano-playing girls from Table XI were averaged to obtain the results for the two hundred girls shown in Table XVIII.

TABLE XVIII

Median and Quartiles of 200 Girls for 50-90 Hours

Hours of Practice	50	60	70	80	90
First quartile.....	68.3	88.5	114.1	136.2	159.7
Median.....	79.9	108.0	133.3	156.7	180.0
Third quartile.....	94.7	124.5	153.1	177.8	200.1

The educational measurements in Tables XVII and XVIII are shown graphically in Figures XVI, XVII and XVIII. Figure XVI shows the learning curve for the one hundred boys, Figure XVII gives the learning curve for the two hundred girls, and Figure XVIII compares the improvement of the two groups from the 50th to the 90th hours of practice.

The conclusion to be drawn from a study of the tables and curves for the period from the 50th to the 90th hours of practice is identical with that for the first thirty-five hours of practice. The girls as a group surpass the boys as a group in the acquisition of speed, but at some stages of the work the boys are ahead of the girls. The best individuals among the boys are the equal of the best individuals among the girls. Towards the 90th hour the girls seem to increase their supremacy over the boys, as shown by the divergence of the median learning curves in Figure XVIII, but owing to the organization of the school, the boys as a rule choosing accountancy and the girls stenography, and the periods of practice varying for these options, it is impossible to follow the comparison further.

FIGURE XVI

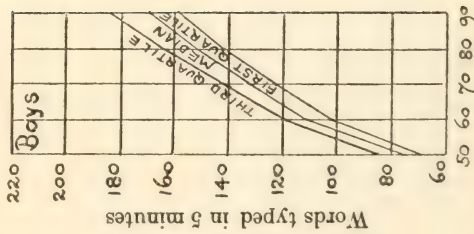


FIGURE XVII

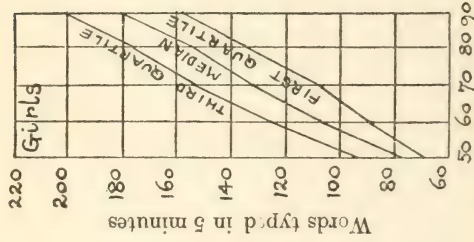


FIGURE XVIII

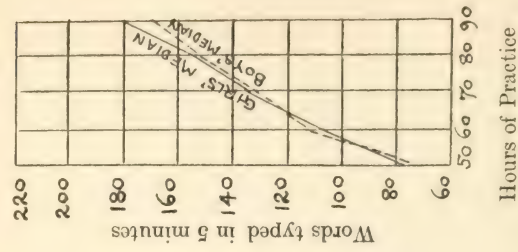


Figure XVI—Improvement Curve of 100 Boys for 50-90 Hours of Practice

Figure XVII—Improvement Curve of 200 Girls for 50-90 Hours of Practice

Figure XVIII—Medians of Boys and Girls Compared for 50-90 Hours of Practice

IV.—INFLUENCE OF RACE

In order to investigate what influence, if any, race exerts on the learning of typewriting, the work of all the Jewish students scattered throughout all the day classes for beginners in typewriting was recorded by itself for comparison with the records of non-Jewish students. Since all the Jewish students were included, they cannot be said to form a selected group of Jewish students with reference to other Jewish students in these classes, and they did the budget work, described above in this paper, along with and under the same conditions as the non-Jew beginners. The total number of pages typewritten and the total number of errors made by each Jewish student in thirty-five hours of budget work are shown in Table XIX.

TABLE XIX

Scores of 50 Jewish Students for 35 Hours of Practice

Jewish Girls	Pages	Errors	Jewish Girls	Pages	Errors	Jewish Boys	Pages	Errors
1 R.A.	23	45	21 D.M.	19	33	1 H.B.	16	28
2 L.B.	34	41	22 R.P.	32	52	2 I.B.	20	39
3 M.B.	26	30	23 N.P.	18	34	3 D.B.	28	41
4 A.B.	46	30	24 L.R.	24	46	4 J.D.	20	47
5 F.B.	57	12	25 M.R.	36	54	5 M.G.	41	42
6 I.C.	27	43	26 R.R.	24	47	6 L.J.	21	28
7 J.C.	44	51	27 B.S.	47	62	7 A.M.	32	41
8 D.C.	22	41	28 A.S.	24	43	8 E.N.	26	49
9 R.C.	31	30	29 B.S.	38	31	9 C.P.	32	54
10 B.F.	29	46	30 F.S.	38	37	10 I.R.	25	56
11 H.F.	36	51	31 J.S.	23	47	11 H.S.	46	49
12 R.F.	33	50	32 E.S.	21	42	12 J.S.	33	40
13 K.G.	30	58	33 S.S.	44	38	13 J.W.	14	27
14 M.K.	35	51	34 D.S.	22	40	14 A.W.	21	35
15 E.K.	51	67	35 F.S.	36	46			
16 L.L.	16	37	36 R.V.	25	36	Total	375	576
17 I.L.	16	30						
18 B.L.	47	59	Total	1,125	1,581			
19 S.L.	26	42						
20 S.M.	25	49						

TABLE XX

SUMMARY OF TABLE XIX

	Jewish Girls	Jewish Boys
Total number of students	36	14
Total pages typed in 35 hours	1,125	375
Total errors made	1,581	576
Average pages per student	31.25	26.78
Average errors per student	43.91	41.14
Average errors per page	1.40	1.53

Comparing the work of Jewish girls and Jewish boys, it will be noticed that the girls averaged more pages, and, what is equally significant, each page of work done by the girls had fewer errors than each page done by the boys.

The combined work of the Jewish boys and girls shown in the above table, compared during the same time and on the same material of practice with the combined records of three hundred non-Jew beginners in typewriting from Tables I, II, and XVII, is given in the table below.

TABLE XXI

Comparison of 50 Jews and 300 Non-Jews for 35 Hours

	Jews	Non-Jews
Total number of students.....	50	300
Total pages typed in 35 hours.....	1,500	8,982
Total errors made.....	2,157	12,958
Average pages per student.....	30.00	29.94
Average errors per student.....	43.14	43.19
Average errors per page.....	1.44	1.44

From these achievement statistics and accuracy records it is seen that during the first thirty-five hours of practice each Jewish student did on an average one-fifth of 1% more pages than each non-Jewish student, and each non-Jewish student averaged one-tenth of 1% more errors than each Jewish student, but the average number of errors per page for Jews and for non-Jews was identical. The margin by which the Jewish students surpassed the non-Jewish students is, however, so slight that it was imperceptible in class work, and it is impossible to represent it by a learning curve separate and distinct from that of the non-Jews.

The weighted first quartiles, medians and third quartiles of the work done in the first thirty-five hours of practice by the two hundred girls in Table XIII were averaged with those for the one hundred boys in Table XV, and the results for the three hundred non-Jews are shown in Table XXII.

TABLE XXII

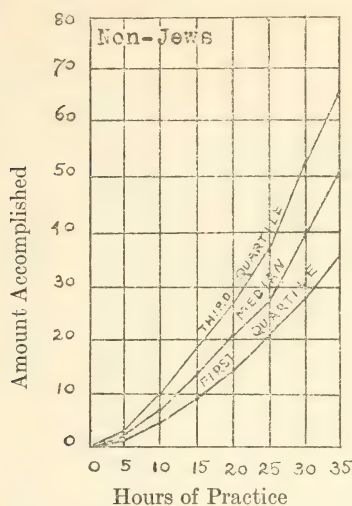
Median and Quartiles for 300 Non-Jews for 35 Hours

Hours of practice	5	10	15	20	25	30	35
First quartile.....	.9	3.1	5.1	4.9	6.1	8.6	8.2
Median.....	1.6	5.9	6.8	6.2	7.8	11.7	10.4
Third quartile.....	2.3	7.7	9.0	8.5	10.4	14.6	12.8

The data of Table XXII are presented in graphical form in Figure XIX, which shows the first quartile, median and third quartile learning curves for three hundred non-Jew students during the first thirty-five hours of practice in typewriting.

Figure XIX

Improvement Curve of Non-Jews for 35 Hours



The comparison of the learning of typewriting by Jews and non-Jews was continued during the acquisition of speed between the 50th and the 90th hours of practice by the same method as described in Chapter II, namely, by weekly five-minute tests. The first quartiles, medians and third quartiles of these tests at intervals of ten hours for the two hundred girls from Table XVIII were averaged with those for the one hundred boys from Table XVII to obtain the results for the three hundred non-Jews shown in Table XXIII.

TABLE XXIII

Median and Quartiles for 300 Non-Jews for 50-90 Hours

Hours of Practice	50	60	70	80	90
First quartile.....	69.1	95.61	119.0	138.4	159.4
Median.....	77.5	110.3	132.8	154.4	174.8
Third quartile.....	89.9	122.0	147.2	171.7	192.6

TABLE XXIV

Median and Quartiles of 50 Jews for 50-90 Hours

Jewish Student	Hours of Practice					Jewish Student	Hours of Practice				
	50	60	70	80	90		50	60	70	80	90
1 R.A.	80	107	153	177	201	26 R.R.	70	95	106	125	150
2 L.B.	112	122	155	184	199	27 B.S.	104	127	144	183	204
3 M.B.	80	106	115	135	147	28 A.S.	84	109	138	144	163
4 A.B.	97	132	199	226	248	29 B.S.	84	114	146	173	196
5 F.B.	69	115	147	174	194	30 F.S.	73	111	133	169	209
6 I.C.	122	163	189	208	250	31 J.S.	107	117	132	145	158
7 J.C.	74	109	143	165	187	32 E.S.	96	135	152	177	194
8 D.C.	76	120	137	170	201	33 S.S.	94	118	131	156	176
9 R.C.	86	123	169	188	227	34 D.S.	88	110	139	145	154
10 B.F.	95	124	166	191	244	35 F.S.	98	126	156	187	208
11 G.F.	81	111	155	171	201	36 R.V.	69	87	98	107	119
12 R.F.	93	119	142	163	185	37 H.B.	64	119	160	180	192
13 K.G.	101	132	157	185	203	38 I.B.	112	155	168	191	209
14 M.K.	76	108	130	153	174	39 D.B.	127	141	173	186	191
15 E.K.	69	111	129	143	155	40 J.D.	104	129	156	190	225
16 L.L.	90	114	141	165	180	41 M.G.	87	128	148	174	181
17 I.L.	73	115	136	173	191	42 L.J.	64	103	120	149	170
18 B.L.	82	121	154	171	195	43 A.M.	89	123	151	160	171
19 S.L.	86	118	135	184	222	44 E.N.	72	119	134	167	186
20 S.M.	79	109	139	160	182	45 C.P.	101	125	162	171	190
21 D.M.	82	133	153	184	201	46 I.R.	86	100	120	137	156
22 R.P.	97	131	140	158	181	47 H.S.	128	154	168	210	240
23 N.P.	107	141	197	229	245	48 J.S.	106	122	157	167	194
24 L.R.	108	132	146	163	195	49 J.W.	86	109	148	172	229
25 M.R.	89	118	148	168	174	50 A.W.	91	106	134	152	177
First quartile.....	79.4	110.3	135.4	158.8	177.5						
Median.....	88.0	118.7	146.4	171.8	193.6						
Third quartile.....	100.6	128.8	157.7	183.9	206.1						

The data of Tables XXIII and XXIV provide the statistical basis for drawing the graphs shown in Figures XX, XXI and XXII. Figure XX depicts the first quartile, median and third quartile learning curves for the three hundred non-Jews, Figure XXI shows similar curves for the fifty Jewish students, and Figure XXII compares the median curves for non-Jews and Jews from the 50th to the 90th hours of practice.

The conclusion reached by a perusal of the tables and improvement curves of this chapter is that the margin of superiority of the Jewish students over the non-Jewish students, which was so slight as to be negligible during the first thirty-five hours of practice, became more significant during the period from the 50th to the 90th hour, but not so pronounced as to make their work noticeably and pre-eminently superior. The superiority of the Jewish students as a class appears to accrue, not so much from natural brilliance, as from their more serious attention and steady application to the work, which may justly be denominated the distinguishing characteristics of their typewriting practice. During the past fifteen years in our school no Jewish student has equalled in any year the highest speed attained by the best non-Jew student, but this result may be due to the relatively small number of Jewish students (about 10%) in a class competing against the relatively large number (about 90%) of non-Jew students, since there is more chance of having a high-grade student in a large group than there is of finding one in a small group of people.

FIGURE XX

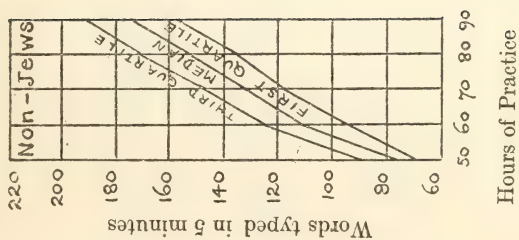


FIGURE XXI

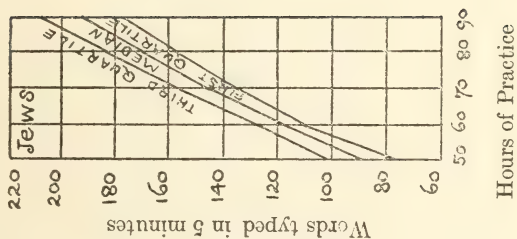


FIGURE XXII

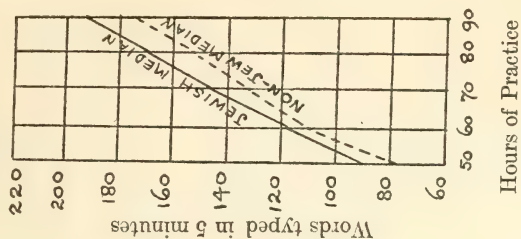


Figure XX—Improvement Curve of Non-Jews for 50-90 Hours of Practice
 Figure XXI—Improvement Curve of Jews for 50-90 Hours of Practice
 Figure XXII—Medians of Jews and Non-Jews Compared for 50-90 Hours

Scores by Ages for 35 Hours of Practice

TABLE XXV

Age 12	Pages	Errors	Age 13	Pages	Errors	Age 14	Pages	Errors	Age 15	Pages	Errors	Age 16	Pages	Errors	Age 17	Pages	Errors	Age 18	Pages	Errors	Age 19	Pages	Errors
1 V.B.	28 59		1 E.N.	26 49		1 D.C.	32 34		1 J.G.	34 57		1 C.A.	30 42		1 J.G.	22 45		1 R.N.	20 39		1 W.R.	22 25	
2 A.C.	23 48		2 H.B.	11 27		2 R.L.	22 28		2 G.S.	36 64		2 R.A.	30 48		2 J.H.	17 38		2 G.K.	30 58		2 L.H.	25 64	
3 A.S.	16 46		3 E.D.	26 63		3 R.P.	47 34		3 R.A.	63 45		3 C.B.	22 34		3 G.T.	38 44		3 G.F.	28 52				
4 C.M.	27 57		4 P.P.	20 61		4 W.S.	28 48		4 P.B.	21 35		4 M.G.	41 42		4 D.G.	22 44		4 G.K.	32 60				
			5 F.K.	37 45		5 G.W.	30 54		5 I.C.	44 51		5 A.M.	32 41		5 B.H.	19 36		5 M.M.	25 49				
			6 M.G.	24 53		6 D.C.	27 43		6 V.D.	35 27		6 M.L.	19 37		6 K.G.	66 35		6 K.G.	24 46				
			7 T.O.	33 37		7 I.C.	22 41		7 H.F.	36 51		7 L.L.	16 43		7 C.K.	45 38							
			8 R.A.	34 37		8 F.S.	36 46		8 R.P.	32 52		8 L.J.	21 28		8 V.P.	42 25							
			9 M.A.	22 35		9 E.S.	27 43		9 L.R.	19 44		9 J.K.	24 30		9 W.E.	15 37							
			10 V.B.	28 59		10 B.S.	38 31		10 D.S.	22 40		10 R.F.	33 50		10 G.F.	18 41							
			11 B.N.	31 57		11 H.Y.	63 54		11 W.D.	29 45		11 B.G.	27 41		11 M.K.	17 42							
			12 E.B.	19 38		12 D.B.	28 41		12 A.M.	25 44		12 M.M.	19 36		12 N.R.	52 22							
			13 F.F.	30 53		13 J.R.	29 48		13 W.M.	26 42		13 T.M.	26 56		13 M.M.	36 52							
			14 M.H.	34 53		14 A.T.	21 30		14 H.B.	35 52		14 E.R.	14 30		14 J.B.	55 36							
			15 M.M.	10 25		15 E.P.	27 47		15 I.L.	16 30		15 K.C.	26 49		15 B.C.	24 52							
			16 M.E.	71 59		16 E.B.	28 36		16 D.M.	19 33		16 G.E.	24 39		16 M.P.	52 52							
			17 L.D.	26 60		17 M.L.	23 45		17 H.D.	33 36		17 C.H.	47 50		17 E.P.	53 48							
			18 M.C.	57 67		18 A.T.	30 57		18 H.G.	18 34		18 A.K.	23 49		18 E.S.	49 36							
			19 E.L.	35 36		19 D.A.	35 37		19 A.H.	15 33		19 A.R.	26 36		19 A.A.	26 44							
			20 F.F.	37 49		20 J.B.	39 40		20 W.A.	29 51		20 H.S.	46 49		20 G.B.	30 49							
			21 C.A.	24 56		21 G.B.	36 45		21 W.C.	20 29		21 O.L.	19 35		21 W.B.	42 54							
			22 C.R.	61 62		22 L.C.	31 45		22 R.C.	30 42		22 R.R.	24 47		22 S.B.	38 49							
			23 E.S.	40 60		23 G.C.	22 45		23 B.D.	25 55		23 I.S.	38 36		23 D.C.	26 48							
			24 G.W.	26 52		24 P.F.	22 45		24 L.E.	32 52		24 D.S.	28 42		24 T.D.	35 57							
			25 W.F.	20 48		25 H.G.	29 49		25 A.J.	31 43		25 J.A.	48 48		25 M.B.	48 38							
			26 D.S.	52 65		26 F.C.	29 52		26 E.M.	26 44		26 T.C.	30 50		26 M.W.	32 65							
			27 J.H.	30 40		27 V.L.	35 48		27 H.M.	39 46		27 K.C.	79 32		27 E.C.	18 49							
			28 W.A.	30 49		28 L.M.	31 40		28 A.P.	17 41		28 A.F.	35 67		28 C.B.	28 41							
						29 I.R.	25 56		29 A.R.	37 38		29 A.H.	32 51		29 J.L.	27 50							
						30 R.S.	21 48		30 V.T.	24 51		30 K.M.	65 57		30 P.V.	29 62							
						31 J.W.	14 27		31 B.T.	23 31		31 W.K.	51 64		31 T.S.	49 58							
						32 H.W.	30 29		32 W.C.	31 54		32 G.Q.	41 60		32 G.W.	26 39							
						33 J.A.	17 37		33 J.D.	25 43		33 M.W.	50 50		33 E.W.	31 47							
						34 A.T.	28 38		34 M.D.	25 42		34 I.B.	44 45		34 A.C.	22 40							
						35 K.B.	30 43		35 K.F.	33 44		35 P.B.	30 43		35 A.D.	26 50							
						36 I.D.	38 40		36 M.G.	30 28		36 H.C.	18 54		36 E.C.	35 51							
						37 M.D.	37 57		37 D.G.	31 51		37 G.D.	18 40		37 T.K.	28 43							
						38 E.D.	20 41		38 M.J.	28 47		38 R.F.	26 46		38 K.M.	28 46							
						39 L.K.	39 45		39 I.L.	36 55		39 R.L.	22 56		39 K.R.	24 53							
						40 A.R.	27 41		40 K.M.	28 37		40 J.L.	24 46		40 G.C.	55 49							

V.—INFLUENCE OF AGE

In order to investigate whether beginners of different ages working under the same conditions learn typewriting at the same rate, the names taken alphabetically from the day-school registers with the records of budget work accomplished during the first thirty-five hours of practice were classified according to the ages of the students, which ranged from twelve to nineteen years. The majority of the students were fourteen, fifteen or sixteen years old, and for these ages the first forty names that appeared in the registers were taken. All the students aged twelve, thirteen, seventeen, eighteen and nineteen years were included in the investigation. The medians of work accomplished during intervals of five hours were found for each age group as shown below.

TABLE XXVI

Medians by Ages for 35 Hours of Practice

Medians for	Hours of Practice						
	5	10	15	20	25	30	35
Age 12.....	2.9	3.5	3.9	3.7	4.9	3.9	2.9
Age 13.....	2.9	4.3	5.3	5.9	5.4	4.8	3.8
Age 14.....	1.6	4.5	4.6	4.9	4.8	6.9	4.5
Age 15.....	1.3	4.2	4.9	4.6	4.9	6.6	4.2
Age 16.....	2.1	4.4	4.9	4.8	5.5	6.3	4.3
Age 17.....	3.2	4.9	5.9	5.9	5.7	4.3	3.6
Age 18.....	3.8	3.9	4.9	4.9	4.9	3.8	3.3
Age 19.....	1.5	4.0	2.5	4.5	4.0	2.5	4.5

The intention was to show by a curve the work accomplished according to age, but it will be seen that the results achieved are so uniform, varying only by a fraction of a page in most cases, that it is not feasible to show this difference by a graph. However, the total results accomplished during the thirty-five hours accentuate any differences in the age groups as shown below.

TABLE XXVII

Comparative Summary of Work by Ages for 35 Hours

Age	No. of Students	Total Pages	Total Errors	Average Pages per Student	Average Errors per Student	Average Errors per Page
12	4	94	210	23.50	52.50	2.2
13	28	894	1,398	31.92	49.93	1.5
14	40	1,193	1,708	29.83	42.70	1.4
15	40	1,158	1,739	28.95	43.48	1.5
16	40	1,268	1,799	31.70	44.98	1.4
17	40	1,345	1,805	33.63	45.12	1.3
18	6	159	304	26.50	50.66	1.9
19	2	47	89	23.50	44.50	1.9

From this summary it will be seen that beginners in typewriting at the age of twelve years appear to be decidedly lower in ability than students at the age of thirteen, fourteen, fifteen, sixteen or seventeen years. Students between the ages of thirteen and seventeen appear to be about equal in ability. Students aged eighteen and nineteen appear to be less efficient than those aged from thirteen to seventeen years.

Some reader may object that very few students are included at the ages of twelve, eighteen and nineteen. This is true, but the results coincide with my experience for the last fifteen years. Students twelve years old are too young to learn typewriting efficiently. They find the work too difficult or they regard the typewriter as a plaything. Any students aged eighteen or nineteen that have come to our school as beginners in typewriting in the day school have been retarded in their previous work on account of their poor native ability, and naturally have not shown brilliance in typewriting. In the night school also the achievement of the older students is of a lower order, but other subtle factors may be operative in this case to produce this effect, as shown in the chapter on night-school work. At the age of eighteen or nineteen and thereafter a person would have more difficulty in learning to play the piano, for the reason that motor habits have become more firmly established than in the younger students, and therefore psycho-physical co-ordinations are slower and more clumsily made. The same explanation of the slowness and awkwardness of the mental-manual co-ordinations of these older students accounts for their smaller achievement as beginners in learning to typewrite.

VI.—INFLUENCE OF DAY AND EVENING SESSIONS

Eleven years ago, when evening classes were inaugurated in typewriting at the High School of Commerce, owing to its being my first experience in night-school work, I naturally introduced the day-school course without making any change in it or in the number of mistakes allowed per page of budget work. I thought that the night-school students, being more mature, would complete the same work in two forty-minute periods during the six months' course, amounting to thirty-two hours, as the day-school students accomplished in thirty-five hours. The first year's work was very disappointing, as very few night-school students were able to get the work finished. Year by year the course for evening students was curtailed, and four errors were allowed, instead of three per page as in the day school. As a result of this experience it was obvious to me that the ability of night-school students to learn typewriting is considerably lower than that of day students, but how much lower? The purpose of the following investigation is to obtain definite achievement statistics for comparison of ability of night-school and day-school students as beginners in typewriting.

TABLE XXVIII

Scores of 100 Night Students for 16 Hours of Practice

Student	Pages	Errors	Student	Pages	Errors	Student	Pages	Errors	Student	Pages	Errors
1 M.A.	8	20	26 M.C.	11	31	51 E.S.	3	10	76 A.R.	4	15
2 J.D.	10	25	27 G.D.	12	42	52 E.B.	10	28	77 D.S.	6	22
3 M.F.	7	20	28 P.E.	16	45	53 N.C.	18	51	78 E.S.	12	27
4 V.G.	2	8	29 I.G.	12	37	54 L.C.	6	16	79 S.A.	6	19
5 I.H.	12	34	30 A.G.	18	52	55 C.C.	16	51	80 R.T.	11	31
6 A.J.	0	0	31 M.J.	17	48	56 G.C.	13	37	81 A.W.	8	30
7 H.L.	10	29	32 M.L.	11	33	57 I.D.	12	22	82 P.C.	4	14
8 G.L.	3	8	33 S.M.	15	41	58 F.J.	12	29	83 L.D.	12	37
9 J.M.	8	19	34 E.M.	11	27	59 J.L.	14	37	84 M.K.	9	23
10 L.P.	8	22	35 C.P.	10	27	60 M.K.	15	53	85 J.L.	5	18
11 J.S.	4	15	36 F.T.	9	29	61 B.N.	13	40	86 F.L.	14	32
12 W.B.	18	51	37 D.T.	10	22	62 J.W.	9	26	87 N.M.	12	25
13 M.D.	3	9	38 H.W.	12	33	63 J.H.	1	4	88 E.M.	7	26
14 E.F.	5	14	39 M.W.	7	17	64 E.H.	4	12	89 C.M.	11	41
15 M.G.	6	17	40 R.P.	7	19	65 H.H.	3	11	90 T.O.	4	8
16 I.H.	11	22	41 O.P.	12	31	66 D.H.	7	24	91 L.R.	7	25
17 A.J.	16	46	42 M.R.	9	25	67 M.H.	10	36	92 G.R.	18	49
18 M.J.	4	11	43 A.A.	6	14	68 F.H.	6	22	93 K.R.	8	27
19 D.M.	2	5	44 M.A.	4	14	69 T.H.	9	23	94 R.S.	18	38
20 S.M.	19	49	45 G.B.	11	30	70 C.J.	6	16	95 J.S.	11	32
21 H.M.	5	14	46 R.F.	13	28	71 O.L.	6	18	96 M.C.	3	11
22 G.B.	14	40	47 A.G.	6	18	72 M.M.	5	19	97 V.C.	4	16
23 D.B.	4	13	48 E.L.	13	41	73 W.M.	9	35	98 V.D.	13	33
24 E.B.	7	23	49 W.P.	4	9	74 L.N.	12	30	99 E.D.	4	14
25 C.B.	15	50	50 A.R.	11	29	75 H.N.	3	12	100 S.F.	10	26

SUMMARY OF TABLE

Total pages typed by 100 night students regular in attendance during 16 hours of practice....	911
Total errors by these 100 night students.....	2,607
Average pages per student.....	9.11
Average errors per student.....	26.07
Average errors per page.....	2.86

TABLE XXIX

Scores of 100 Day Students for 16 Hours of Practice

Student	Pages	Errors	Student	Pages	Errors	Student	Pages	Errors	Student	Pages	Errors
1 C.A.	12	16	26 R.P.	9	19	51 H.H.	11	19	76 D.C.	15	14
2 R.A.	11	13	27 L.R.	5	11	52 B.J.	11	18	77 G.D.	6	11
3 C.B.	9	11	28 F.S.	14	13	53 E.J.	12	14	78 W.E.	5	13
4 D.C.	17	13	29 E.S.	11	17	54 M.K.	12	17	79 G.F.	6	17
5 J.G.	10	19	30 D.S.	3	3	55 M.K.	26	12	80 R.F.	11	14
6 M.G.	17	14	31 B.S.	13	4	56 C.K.	21	10	81 L.G.	21	6
7 J.G.	17	17	32 H.Y.	27	17	57 C.K.	8	8	82 P.G.	7	9
8 R.L.	8	9	33 J.A.	21	15	58 K.M.	28	17	83 R.G.	9	19
9 A.M.	11	14	34 G.B.	23	16	59 W.M.	19	21	84 N.H.	6	11
10 L.P.	12	15	35 L.B.	17	20	60 S.N.	21	21	85 A.H.	7	10
11 R.P.	24	14	36 M.C.	9	15	61 M.O.	20	20	86 H.H.	11	18
12 G.S.	18	19	37 E.C.	8	18	62 T.O.	12	23	87 M.H.	10	13
13 W.S.	10	13	38 T.C.	8	19	63 V.P.	20	5	88 D.I.	5	7
14 G.W.	8	17	39 K.C.	38	11	64 G.Q.	18	19	89 G.J.	9	15
15 R.A.	3	8	40 N.D.	13	10	65 E.R.	14	15	90 M.K.	6	15
16 M.B.	8	4	41 A.F.	18	22	66 E.W.	12	23	91 R.L.	9	20
17 H.B.	3	8	42 K.G.	31	10	67 M.W.	23	13	92 J.L.	6	14
18 P.B.	25	12	43 N.G.	22	6	68 D.W.	18	8	93 S.M.	5	9
19 I.C.	4	9	44 M.G.	7	15	69 E.W.	8	12	94 N.N.	8	14
20 I.C.	14	20	45 M.H.	5	11	70 I.B.	15	16	95 K.N.	6	12
21 D.C.	5	7	46 M.H.	13	14	71 E.B.	6	5	96 N.R.	19	9
22 V.D.	12	7	47 V.H.	10	12	72 P.B.	9	14	97 E.S.	8	11
23 H.F.	10	12	48 F.H.	12	22	73 H.C.	6	18	98 S.S.	19	10
24 M.L.	5	10	49 A.H.	16	20	74 M.C.	12	12	99 R.S.	23	20
25 L.L.	3	9	50 H.H.	7	15	75 J.C.	9	18	100 M.T.	19	11

SUMMARY OF TABLE

Total pages typed by 100 day students regular in attendance during 16 hours of practice.....	1,273
Total errors by these 100 day students.....	1,365
Average pages per student.....	12.73
Average errors per student.....	13.65
Average errors per page.....	1.07

Table XXVIII shows the total number of budget pages typed and the number of errors made by each of one hundred night-school beginners in typewriting during the first sixteen hours of practice. The names of these students were taken alphabetically from the class registers, and the only thing kept in mind in their selection was to pick out those who had been regular in attendance. This was absolutely necessary owing to the frequent absences and the abnormal wastage in the night-school classes from students dropping out. These one hundred students had been present every evening, or absent not more than one evening, and are absolutely representative of night-school students of regular attendance. They all received the same initial instruction, did the same budget work, and used the same machines as the day students. They were allowed a maximum of four mistakes per page, which concession would tend to increase the output of the evening classes, since the day students were only allowed a maximum of three errors per page.

These students commenced work in the evening classes at the first of October, and typed for two periods of forty minutes each during every week till the Christmas vacation, a total of twenty-four periods or sixteen hours. An inventory was taken at the end of that particular time, because one or two of the best in every class were just finishing up the eighteen pages of budget work that form the short course for evening classes, and, as the night-school work is individual work, these students would then go on with speed lessons which are different from and cannot very well be compared with the budget pages which the rest of the class would be typing.

Table XXIX shows the total pages typed and the total number of errors made in the first sixteen hours of practice on the same budget work by each of one hundred day-school students. The names were taken just as they appeared on the class registers, alphabetically arranged.

Comparison of the achievement of the night-school students with that of the day-school students is shown by the following tabular summary of Tables XXVIII and XXIX:

TABLE XXX

Comparison of Night and Day Students for 16 Hours

	Night School	Day School
Total pages typed.....	911	1,273
Total errors made.....	2,607	1,365
Average pages per student.....	9.11	12.73
Average errors per student.....	26.07	13.65
Average errors per page.....	2.86	1.07

From the above figures it will be seen that day-school beginners achieve 40% (39.7%) more work than night-school students of regular attendance; and that the night-school students make an average number of errors per page of 167.3% more than the day-school students.

Having satisfied myself that the average ability to achieve work is lower in night-school students than in day-school students (and night-school teachers are unanimous in agreeing that this is true in other subjects as well), I began to search for reasons for this lower efficiency in the learning of typewriting, and have found the following to be contributory factors:

- (1) Although intelligence and speed in typewriting do not correlate highly, the more intelligence that a beginner can bring into use in the learning stage, the more likely he is to succeed. It is very true that a large percentage of night-school students are ones who made a failure of their day-school course.
- (2) Fatigue from their regular occupation during the day makes it impossible for night-school students to start in as fresh as day-school students begin their work in the morning.
- (3) The older a student is the more self-conscious he seems to be of his efforts. He is ashamed of himself for not being able to do what he sees some younger pupil is able to do. This interferes with concentration.
- (4) Older night-school students are more or less nervous, and in consequence many keep their fingers and arms unnaturally

tense and rigid. It is only when they relax that they being to succeed. The same is true of penmanship.

- (5) The older a night-school student is the more set are his mental habits. He is out of the way of studying and cannot learn as quickly as a younger day-school student whose main business is studying.

VII.—INFLUENCE OF ELIMINATION

Effect on Whole Class Achievements

In our study of the ability of night-school beginners in typewriting in the last chapter, even though care was taken to include only those who had been regular in attendance, we saw that day-school ability achieved 40% more work than that of night students; but it is not this poor ability of night-school students in regular attendance that is the source of the greatest loss in efficiency of the night school as compared with the day school. The greatest causes of the inability of night schools to function with maximum efficiency are the frequent absences and the abnormal wastage of students by dropping out altogether before completing their courses. This is true for all subjects perhaps even more so than for typewriting, as can be seen from the fact that every month throughout each year of the ten years in which typewriting has had a place on the curriculum of our evening classes, the actual attendance in the typewriting classes has been consistently larger than in classes in any other subject. These frequent and prolonged absences and the elimination of students lower the composite achievement of a whole class of night-school beginners in typewriting, so that the day-school potentiality is much higher than 40% above it.

The purpose of this particular section of this paper is to prove the above statement, and the plan that I have adopted is to collect from the class registers which provided the data for Tables XXVIII and XXIX the names of all those students that were passed over and omitted from those tables because of absence, and then to place opposite those names the quota of pages done during the students' attendance. For the day-school this complementary list is not large, since absences are due almost entirely to illness and comparatively few students drop out during the term. For the night school the list is a large one, since to get one hundred names of regular attenders for Table XXVIII about two hundred names had to be rejected on account of absence or elimination.

Table XXXI shows for the sixteen hours of practice mentioned in the preceding chapter the achievements of those night-school students of irregular attendance who were purposely omitted from Table XXVIII. These two tables are complementary, and, when their results are combined, they give the composite achievement of all the evening students on the roll in the classes examined, irrespective of absence or elimination. as follows:

TABLE XXXI

Complementary Table for Night Students

Student	Pages	Student	Pages	Student	Pages	Student	Pages
1 J.A.	5	51 L.R.	5	101 D.R.	0	151 E.F.	15
2 J.B.	0	52 W.P.	0	102 M.S.	9	152 R.G.	18
3 W.B.	0	53 B.S.	1	103 E.S.	11	153 N.H.	3
4 M.B.	0	54 W.S.	17	104 A.B.	1	154 M.H.	0
5 A.B.	10	55 D.T.	13	105 C.B.	10	155 D.H.	9
6 A.B.	0	56 G.T.	9	106 J.B.	12	156 V.H.	6
7 L.C.	0	57 L.W.	3	107 M.B.	11	157 M.M.	4
8 E.C.	3	58 G.A.	6	108 H.A.	6	158 I.P.	12
9 E.C.	0	59 G.B.	2	109 R.B.	10	159 M.P.	12
10 C.D.	4	60 M.B.	0	110 C.B.	10	160 A.R.	16
11 E.E.	9	61 A.C.	0	111 S.B.	1	161 G.R.	6
12 M.F.	9	62 J.C.	0	112 O.D.	6	162 M.S.	9
13 E.F.	0	63 W.C.	0	113 E.D.	3	163 I.W.	12
14 J.G.	6	64 S.D.	0	114 E.G.	1	164 M.N.	17
15 F.G.	11	65 R.F.	3	115 H.G.	1	165 F.A.	4
16 H.H.	0	66 I.H.	10	116 E.G.	8	166 F.B.	0
17 E.H.	5	67 F.M.	0	117 M.G.	3	167 L.B.	9
18 J.H.	4	68 O.M.	0	118 M.H.	6	168 E.C.	4
19 J.J.	0	69 O.P.	3	119 H.H.	1	169 C.C.	0
20 F.M.	10	70 B.P.	2	120 L.H.	5	170 A.F.	3
21 J.M.	3	71 N.R.	0	121 A.H.	0	171 V.F.	12
22 G.M.	8	72 I.R.	0	122 E.H.	12	172 A.G.	6
23 H.M.	10	73 H.R.	2	123 V.I.	3	173 D.G.	0
24 A.M.	10	74 D.S.	11	124 H.J.	11	174 M.G.	3
25 L.P.	7	75 R.S.	9	125 J.J.	1	175 R.G.	3
26 G.P.	3	76 M.T.	3	126 H.L.	5	176 H.H.	3
27 B.R.	13	77 L.T.	0	127 E.M.	7	177 J.H.	0
28 I.T.	0	78 A.W.	1	128 J.M.	1	178 V.H.	3
29 L.B.	0	79 E.W.	6	129 G.M.	1	179 E.I.	6
30 M.B.	11	80 R.B.	6	130 J.M.	9	180 V.K.	2
31 L.B.	12	81 M.C.	11	131 F.P.	3	181 H.K.	3
32 E.C.	10	82 K.C.	8	132 J.R.	0	182 A.M.	2
33 O.C.	3	83 R.D.	13	133 F.R.	3	183 M.N.	9
34 B.C.	4	84 B.D.	11	134 V.R.	0	184 M.N.	0
35 C.D.	15	85 F.E.	11	135 C.R.	5	185 N.N.	0
36 M.D.	0	86 M.G.	5	136 J.S.	9	186 M.P.	2
37 J.E.	0	87 B.H.	15	137 M.W.	0	187 M.Q.	12
38 J.F.	8	88 M.H.	6	138 R.W.	8	188 J.R.	0
39 J.G.	1	89 A.J.	5	139 S.W.	7	189 H.R.	4
40 M.G.	8	90 M.K.	11	140 A.W.	15	190 G.R.	8
41 M.G.	5	91 G.L.	9	141 S.W.	4	191 W.S.	16
42 E.H.	0	92 N.L.	0	142 A.S.	0	192 J.S.	0
43 I.J.	8	93 I.L.	15	143 B.B.	9	193 I.S.	2
44 E.J.	12	94 H.M.	11	144 A.B.	16	194 V.S.	2
45 M.J.	0	95 F.K.	7	145 A.B.	3	195 P.T.	0
46 N.K.	0	96 B.M.	9	146 B.C.	0	196 A.T.	6
47 W.M.	0	97 H.O.	16	147 E.C.	10	197 H.T.	4
48 J.M.	11	98 D.P.	0	148 W.C.	6	198 D.W.	3
49 M.M.	0	99 R.R.	6	149 E.D.	6	199 F.W.	4
50 W.P.	16	100 F.R.	6	150 E.D.	10		

Total....1,094

TABLE XXXII

Complementary Table for Day Students

1 M.B.	3	3 M.K.	2	5 E.E.	6	7 A.B.	6
2 E.D.	6	4 W.M.	4	6 M.P.	5	8 E.H.	3

Total..... 35

Total pages done in 16 hours by evening classes with 299 students on the roll	2,005
Average number of pages done in 16 hours per evening student on the roll	6.7

Table XXXII gives for the sixteen hours of practice the achievements of those day students of irregular attendance who, because of absences, were not included in Table XXIX. These two tables are therefore complementary, and, when combined, their results show the composite achievement of all the day students on the roll in the classes examined, irrespective of absence or elimination, as follows:

Total pages typed in 16 hours by day classes with 108 students on the roll	1,308
Average number of pages done in 16 hours per day student on the roll	12.1

Coming now to a comparison of the results of the combined summaries above, we find that with the same time and material for practice each night-school beginner registered on the class roll for typewriting averaged 6.7 pages; and each day-school beginner registered on the class roll for typewriting averaged 12.1 pages, or 80.6% more than the night-school students. This lowered potentiality of the whole class of night-school beginners in typewriting, compared with the whole class of day-school students, is due to frequent and prolonged absences and abnormal elimination of students in the night-school.

The extent and significance of elimination and wastage of students by withdrawal, both in the day-school and in the night-school, can be seen most easily in connection with the small number of senior classes compared with the large number of junior classes in the school. This, of course, applies to all the subjects as well as typewriting. In our day-school we have ten classes each of forty students taking first-year typewriting, but these dwindle in second-year typewriting to five classes, and in third-year typewriting to one class. The night-school has thirteen first-year classes in typewriting, but only two second-year classes, and one third-year class, the last named class having the largest average attendance of all the classes in this subject.

The day students are compelled by the school law and parental authority to attend, and the causes of elimination are few in number, the chief ones being sickness of parents or pupils, and financial or social conditions in the home. These causes are not dependent upon inability to learn to typewrite, and the proportion of day students who withdraw for the latter reason is negligible. On the other hand, especially after the Christmas and Easter vacations, the main cause of withdrawal in the day-school is sufficient proficiency in shorthand and typewriting to enable the student to fill an office position acceptably before the end of the course, though even in this case the financial and social conditions of the home exert their influence as well.

The causes of elimination in the night-school are more numerous and varied. Financial and social conditions of the home are not operative in making a student withdraw from night school, since such attendance does not interfere with his daily vocation. Financial, social and

business conditions are rather a reason for attendance at night school. Night-school students attend voluntarily, and the regularity of their attendance is largely a matter of mood with them. A very potent factor in their elimination is undertaking too ambitious a program of studies, involving too many nights' attendance or too much homework, the result being discouragement and withdrawal. Some students have not the will power to resist the attraction of social functions, and after enjoying these they find night school irksome. Some find they are too much fatigued after their day's work to continue the night-school course which they have started. Other older and more mature students, owing to their mental and motor habits being firmly established and the consequent awkwardness and slowness of making psycho-motor co-ordinations, become discouraged by the small output of their work, and withdraw. Thus inability to learn to typewrite is a cause of elimination in the night school.

Finally, as the outcome of ten years' of experience in night-school work, I am going to formulate certain general conclusions I have reached with reference to the teaching of typewriting in night schools, all of which have an influential bearing on the amount and rate of improvement of the learners, and on combating elimination.

- (1) Night-school students cannot typewrite as much work in a given time as day students.
- (2) The course must be shorter, and therefore easier, than for day-school students.
- (3) Night-school students cannot typewrite as accurately as day students.
- (4) More errors must, therefore, be allowed in the work of night students than in the work of day students.
- (5) Exacting too high a standard of accuracy is discouraging to a night-school beginner in typewriting.
- (6) Such a number of mistakes should therefore be allowed as will produce confidence in the mind of the pupil that he can accomplish the task and at the same time provide a sufficient foundation of accuracy.
- (7) More latitude in the way of conduct in class must be allowed to mature night-school students than to younger day-school students.
- (8) Encouragement and praise must be given to the older night-school students for poorer work than might even be accepted from day students.
- (9) More allowance must be made in the night school for moods, physical exhaustion, and mental fatigue than in the day school.
- (10) Pleasant and cordial relationship between teacher and students has more to do with good attendance in night classes than in the day classes, since night-school attendance is voluntary, and day-school attendance is compulsory by law and parental authority.
- (11) Night-school students, after the first lesson when all start off even, proceed as individuals in their work, each going at his

own rate; whereas the most economic plan for the day students is to keep them all working together on one section of the work for the same period of time.

VIII.—INFLUENCE OF RELEARNING

The data showing the influence of relearning on improvability were obtained from an investigation of the retention of skill in typewriting in connection with the regular school work of students known as repeaters, scattered throughout the different classes of beginners in typewriting. These repeaters were students who were repeating their first year's work in the school owing to being plucked (a) in typewriting, or (b) in other school subjects, but not in typewriting at the end of the first year.

The midsummer vacation of about three months intervened between the last day's typewriting of the first year's work and the first day's typewriting of the repeated year's work, during which time, it was afterwards ascertained, none of these particular students had had any practice on a typewriter. In the following September all these students began to repeat the previous year's work along with the beginners at that time.

The courses for the both years were identical with reference to words, pages, budgets, length of periods, duration of course, etc., and the students were the same, but a year older. These students comprised all the repeaters in all the classes of beginners in typewriting, with the exception of one pupil whose name was excluded from the investigation for lengthy absence on account of illness. All the others were regular in attendance, and they cannot be regarded as a selected group, since they included all the repeaters available in all classes. The only condition that differed in the work of the two years was the number of errors allowed per page. During the first year's work a maximum of three errors per page was allowed, while in the repeated year the same pages had to be done with no errors at all in order to be accepted. This higher standard of work with reference to errors would naturally tend to reduce the possible output of approved pages, but in spite of this fact it will be seen that even the repeaters who were plucked in typewriting the year before effected a remarkable increase in the number of pages typed, as compared with their previous year's record.

Table XXXIII gives the record of ten repeaters who failed in typewriting during the first year, showing the amount accomplished during that year and also during the repeated year's work. The increase in accuracy was 100%, and the average increase in work 125.3% per student.

Table XXXIV records the work of twenty repeaters who failed at the end of the first year in other school subjects but not in typewriting, and shows similar details to those in Table XXXIII. The increase in accuracy was also 100%, and the average increase in work done was 142.4% per student.

TABLE XXXIII
Scores for Rearing by Failures in Typewriting

Student	First year Budgets			Repeated year Budgets			Total Pages	Gain Per cent
	I	II	III	IV	V	VI		
1 A.B.	3	6	6	6	3	3	27	55.55
2 H.C.	3	3	6	3	3	1	19	36.84
3 J.S.	3	4	3	5	3	1	19	26.31
4 H.C.	3	4	3	3	3	0	16	31.25
5 H.P.	4	3	6	3	3	3	22	113.63
6 M.I.	3	3	4	3	3	3	19	363.16
7 E.S.	3	4	4	3	3	2	19	221.05
8 S.R.	3	4	8	5	3	2	25	148.00
9 J.H.	4	3	4	3	3	3	20	180.00
10 J.M.	3	3	3	3	1	3	16	75.00

TABLE XXXIV

Scores for Rearing by Non-Failures in Typewriting

Student	First year Budgets			Repeated year Budgets			Total Pages	Gain Per cent
	I	II	III	IV	V	VI		
1 P.N.	4	6	8	6	3	6	33	181.81
2 I.T.	4	10	17	7	6	6	50	26.00
3 W.G.	3	4	13	7	3	3	33	87.87
4 E.M.	3	8	5	3	3	3	25	140.00
5 E.M.	8	10	9	5	4	4	40	72.50
6 K.C.	6	6	6	5	3	3	29	355.17
7 G.M.	4	6	4	6	3	3	23	121.74
8 E.V.	3	4	6	3	3	3	25	120.00
9 A.F.	3	9	9	8	6	4	39	66.66
10 V.S.	3	4	8	9	4	5	33	87.87
11 C.M.	3	5	6	4	1	3	22	131.81
12 E.S.	3	4	6	5	3	3	24	175.00
13 J.M.	7	8	20	13	6	6	60	123.33
14 R.C.	9	6	10	5	6	6	42	130.95
15 J.H.	6	5	3	8	1	3	26	226.92
16 C.S.	6	9	5	6	4	3	33	260.60
17 M.H.	7	7	8	12	3	3	40	62.50
18 W.S.	4	5	2	6	1	3	21	228.57
19 J.W.	4	2	7	10	1	3	27	133.33
20 M.B.	3	5	9	6	6	3	32	115.62

Observations re Tables XXXIII and XXXIV

- (1) The relearning of the typewriting shows erratic results, varying from 26% to 363% increase in output of repeated work over the first year's record.
- (2) The group that failed in typewriting during the first year made a lower composite gain and a lower average gain during the repeated year than those who did not fail in typewriting.
- (3) The group with the greater native ability, as shown by the first year's work, showed greater improvement in relearning.
- (4) The initial rapidity of the relearning process is very noticeable, especially in the case of E. S. and W. S. In five hours on Budget I in the repeated year the former equalled and the latter surpassed the total number of pages typed by him during the whole course of thirty-five hours of the first year. In spite of the retardation in output, owing to spoiling pages in order to type them with no errors, it will be seen, on comparing the number of pages of Budget I done in the first five hours of the first year with the number of pages of the same budget typed in the first five hours of the repeated year, that E. S. made a gain of 700%, P. N. of 500%, W. S. of 450%, and C. S. of 400%.

In explanation of the remarkable initial rapidity of the relearning of typewriting, the following factors are suggested as contributory:

- (1) Retention and automatic recall of latent mental habits acquired by the previous year's thinking and practice; for example, knowing that the letter "q" is always followed by the letter "u", the one letter recalls to mind the other. The mind works easily by the law of habit and association along the old combinations.
- (2) Retention and automatic recall of latent motor habits already formed from the previous year's practice; for example, in writing "tion" it was found by some repeaters that the proper finger had gone to the "n" and typed it, even before the mind had attended to that letter, the motor action being set off by the thought or sight of the first part of combination.
- (3) Simplicity and relative easiness of Budget I, due to the elementary nature of the beginnings of the subject.
- (4) Ability to attend to whole groups of letters, without attending to each separate letter, as is done by a mere beginner.
- (5) Absence during the repeated year of all kinds of initial learning difficulties that interfere with the work of a beginner.
- (6) Actual gain in skill in manipulation of the fingers, making the operation of the machine more easy and accurate than for a beginner.
- (7) Confidence in the mind of the relearner from knowing the character of the work he has to do, and the greater ease with which he can now do it.
- (8) Short-cuts on the keyboard, not yet known to the beginner, make it possible for the relearner to find a key from some other key without going back to the "home" row in order to start out from there.

- (9) Renewed interest from the challenge extended to him to do his pages according to the higher standard with no mistakes.
- (10) Success in mastering this new difficulty acts as a tonic and spurs him on to do more and more pages.

IX.—INFLUENCE OF EXTENDED PRACTICE

All the statistics and improvement curves displayed in this dissertation so far have dealt with the learning of typewriting by the touch method from the 1st to the 35th hours of practice on budget work, and from the 50th to the 90th hours of practice for speed. These curves, all of which show a steady ascent and improvement, are really only cross-sections of the complete learning curve, since typewriting is a function which requires a long period of practice before the limit of improvement is reached. The purpose of this chapter is to show the influence of more extended practice on the learning of typewriting.

The method employed was to hold five-minute tests each week during the second year of practice, using the same kind of material as described for this purpose earlier in this paper. The midsummer vacation of about three months intervened between the first year's work and the second year's work, during which time it was afterwards ascertained none of the students mentioned in the following tables had used a typewriter. Most of the students, therefore, started the second year with a lower speed than at the 90th hour of practice at the end of the first year. The students practised nine half-hour periods per week of the second year in typewriting, making a total of one hundred and fifty hours. The periods devoted to class instruction and typing for form are included in this total. Examinations and various interruptions made it undesirable to hold the regular tests during the last few weeks of the year. The scores at intervals of five hours, reckoned as described earlier in this paper, are shown for twenty students in Table XXXV.

All the previous curves have been composite curves, drawn from the median and quartile scores of a large group of students. This was done because the students in the initial stage of practice all had about the same initial ability, and about the same steady rate of improvement, as can be seen from the earlier tables. However, during the second year the initial abilities vary a good deal, and the improvement is rather in spurts than a steady ascent. In order that these important characteristics may not be concealed in composite graphs, individual practice curves are shown for representative students.

Figures XXIII, XXIV and XXV show individual improvement curves for students 7, 8 and 14 in Table XXXV. The first curve is typical of the improvement of the group, while the second represents the progress of the poorest student and the third depicts the progress of the best student in the group. All these curves are plainly much nearer to the horizontal than the curves up to the 90th hour, and thus these curves, from about the 100th to the 235th hours of practice, constitute a long, slightly inclined plateau on the complete learning curve, as compared with the steady and fairly steep ascent of the first ninety hours. This long plateau indicates decreasing returns from practice. Improvement seems to come in little spurts, and then the student falls back to

TABLE XXXV
Scores of 20 Students for 100-235 Hours of Practice

Student	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235
1 J.P.	141	153	147	152	179	187	196	181	199	200	220	205	212	229	227	229	230	229	222	223	233	226	231	247	240	249	239	274
2 M.H.	160	131	153	217	209	211	208	213	195	218	214	225	242	237	246	244	235	239	246	237	253	251	247	259	270	291	299	320
3 V.B.	132	152	166	161	197	189	177	195	180	169	193	178	189	199	205	209	203	210	230	211	219	224	238	247	262	254	261	
4 C.H.	120	188	187	198	208	203	214	214	223	219	211	227	224	230	229	243	239	236	247	261	239	250	251	264	263	277	282	274
5 J.C.	150	199	217	231	216	261	244	236	269	291	274	281	267	286	286	291	292	309	310	300	305	328	329	327	320	325	340	351
6 L.S.	118	131	157	176	200	214	202	228	202	230	226	232	223	213	214	228	222	233	242	241	246	238	224	236	242	239	233	240
7 R.W.	111	177	181	196	224	222	234	221	209	230	251	232	232	253	254	239	233	255	244	242	254	237	237	234	246	271	270	276
8 M.M.	83	112	133	119	125	138	146	153	135	134	159	156	162	151	163	168	170	179	180	181	173	169	177	181	181	170	185	
9 D.W.	133	164	167	192	194	203	208	223	233	233	230	226	235	246	257	251	242	237	260	253	239	237	247	250	266	260	271	
10 V.D.	120	134	156	147	164	147	153	165	185	190	193	199	197	205	200	212	216	230	208	209	217	239	230	240	247	233	238	
11 E.T.	131	156	186	196	177	200	203	218	228	209	230	229	220	222	223	207	233	231	237	239	240	242	236	241	232	235	245	245
12 D.A.	111	165	176	196	186	179	171	199	206	207	201	214	208	216	200	202	221	230	220	225	229	239	235	234	236	241	230	242
13 R.W.	120	161	175	187	216	213	229	203	233	217	241	242	233	228	226	246	260	247	262	268	252	259	254	269	274	269	275	274
14 J.A.	171	181	194	186	221	231	235	258	257	244	265	257	244	266	283	278	290	275	299	289	298	299	315	307	308	324	328	350
15 M.R.	118	151	165	165	167	185	199	191	191	194	194	206	205	207	224	208	211	221	223	239	247	265	263	272	277	277	269	268
16 D.I.	131	137	175	191	211	225	235	241	238	244	230	263	238	262	261	248	256	270	276	287	285	279	299	287	299	289	305	319
17 P.N.	131	150	166	180	197	195	199	213	212	201	219	229	222	229	238	240	246	258	250	244	245	264	280	277	272	266	273	280
18 E.P.	141	173	190	185	210	208	202	203	230	217	213	232	233	214	230	233	255	246	261	266	250	265	249	254	262	273	258	263
19 E.B.	142	149	174	181	186	211	190	202	216	211	214	223	217	220	216	230	218	223	227	223	219	218	237	234	237	241	247	239
20 M.W.	146	171	188	188	195	208	213	220	219	230	229	236	234	234	245	234	236	235	255	259	258	265	267	257	264	269	272	277

TABLE XXXVI
Scores of 14 Students for 250-360 Hours of Practice

Student	250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	345	350	355	360
1 D.A.	180	196	220	214	219	230	216	226	253	261	270	272	253	235	261	250	256	283	290	316	304	315	334
2 V.B.	237	240	297	281	239	252	230	247	251	270	309	284	277	294	267	264	267	292	287	305	326	316	329
3 V.D.	239	262	318	294	298	276	236	243	265	279	254	261	248	265	252	268	283	282	286	322	312	300	329
4 C.H.	250	251	278	273	241	235	244	245	251	250	260	277	254	268	241	264	256	283	269	285	291	288	317
5 M.M.	139	172	189	213	208	220	213	199	229	241	236	247	241	227	249	228	244	254	251	254	283	284	275
6 P.N.	256	272	325	326	317	275	279	241	299	310	303	308	308	326	299	318	285	312	303	323	318	343	350
7 J.P.	200	221	236	260	264	248	254	233	246	257	270	242	260	249	258	244	261	276	272	242	277	289	310
8 M.R.	199	235	220	267	241	237	221	226	237	263	252	264	249	235	253	245	250	254	260	266	276	292	290
9 L.S.	220	251	243	298	278	261	270	259	292	302	273	258	271	260	265	270	284	303	310	312	313	314	337
10 E.T.	238	239	293	271	252	270	245	248	222	238	214	261	270	278	268	264	272	281	288	293	290	297	311
11 R.W.	201	225	252	279	255	269	258	258	271	257	248	228	270	251	264	282	264	267	278	268	290	302	323
12 M.W.	207	222	238	251	240	234	256	239	286	291	268	263	279	269	260	263	300	311	297	328	319	341	339
13 D.W.	226	239	268	291	284	249	264	233	251	281	282	284	288	286	271	263	301	285	293	307	312	319	325
14 R.W.	231	247	278	293	298	278	236	251	262	285	285	291	294	280	271	283	293	310	303	331	354	332	342

a lower level of efficiency for a time, though this retarded efficiency is not indicated by any clear minor plateaus or small level resting places within the long plateau.

It was possible to follow the improvement in typewriting still further in the case of fourteen of these students who returned to school the next year, and so practised typewriting for the third year. Table XXXVI shows the scores made by these students in the weekly five-minute tests from the 250th to the 360th hours of practice.

Figures XXVI to XXIX show in graphical form the improvement of students 4, 6, 7 and 11 in Table XXXVI, and are typical of the progress of the group. The initial rise is due to relearning after the midsummer vacation of about three months. After the students again reached their normal rate, the curves are much nearer to the horizontal than those up to the 240th hour of practice. In fact, the general direction of progress is horizontal, with slight spurts above or relapses below that line. Considering the steady and fairly steep ascent up to the 90th hour, and the long, slightly inclined slope from about the 100th to the 235th hours, the curve for the 250th to the 360th hours of practice forms an extended, almost horizontal plateau on the complete learning curve for typewriting. This signifies constantly diminishing returns in efficiency from continued practice, and the approach of the psychological limit of speed for these students, unless some new interest can be infused into their work to jolt them out of an apparent speed rut.

FIGURE XXIII

Individual Improvement Curve for 100-240 Hours

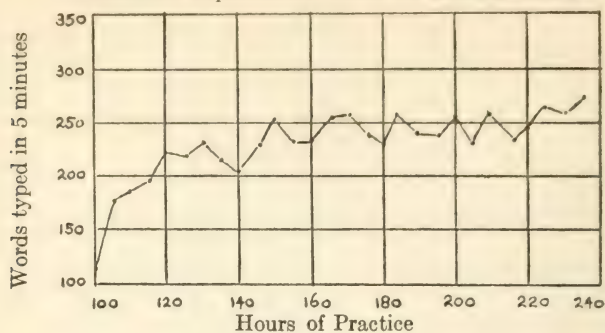


FIGURE XXIV

Individual Improvement Curve for 100-240 Hours

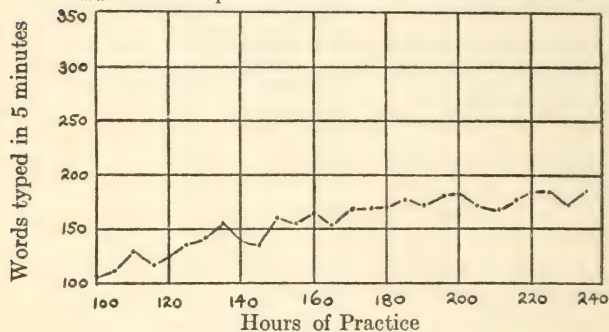


FIGURE XXV

Individual Improvement Curve for 100-240 Hours

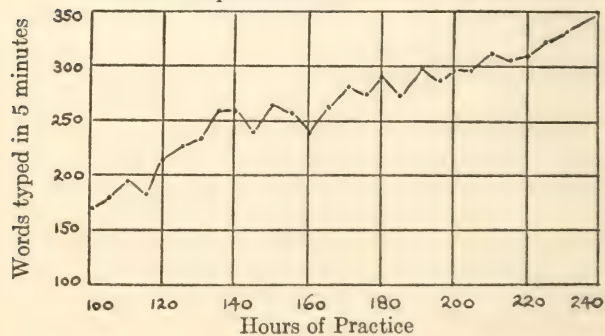


FIGURE XXVI

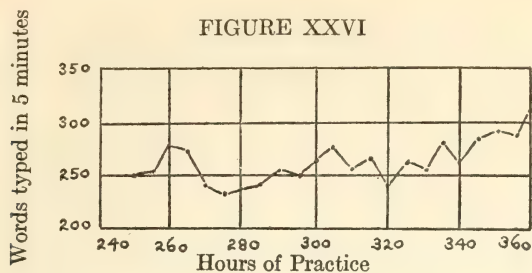


FIGURE XXVII

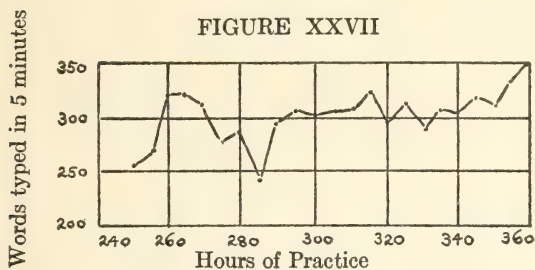


FIGURE XXVIII

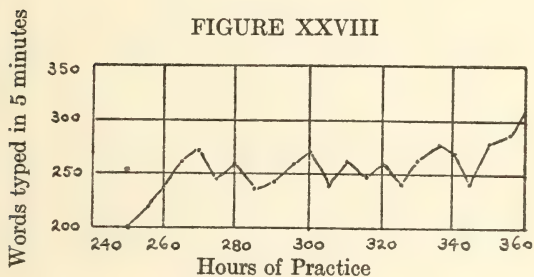
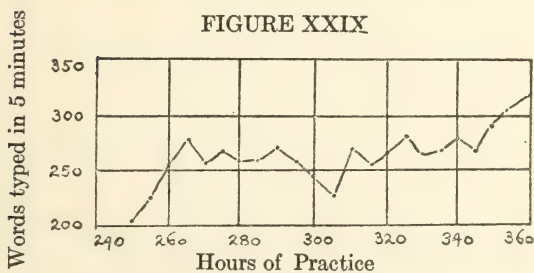


FIGURE XXIX



Figures XXVI, XXVII, XXVIII, and XXIX are Individual Improvement Curves for 250-360 Hours of Practice.

TABLE XXXVII
Classes of Errors in Typewriting

Student	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	Total
1 O.M.	7	..	4	1	..	..	..	..	..	..	..	..	..	..	12
2 G.W.	4	1	1	1	..	..	..	..	..	..	..	..	..	..	7
3 E.G.	9	3	..	..	2	2	..	..	1	..	..	..	..	..	17
4 F.W.	2	..	..	1	..	..	..	2	..	2	..	..	..	..	7
5 Y.S.	13	1	..	..	..	..	..	..	..	..	..	..	..	..	14
6 R.G.	4	2	3	..	1	..	..	..	..	..	..	..	..	..	10
7 B.W.	2	1	..	..	..	1	..	..	..	..	..	..	..	1	5
8 C.M.	9	1	1	2	..	..	..	..	1	..	..	..	1	..	15
9 V.S.	11	..	1	3	..	..	..	..	..	..	..	..	..	..	15
10 G.C.	8	..	1	..	..	..	2	..	..	..	..	..	..	..	11
11 A.M.	2	..	..	1	3	..	..	..	..	..	..	..	..	..	6
12 B.F.	7	1	..	..	..	1	4	..	..	..	..	..	..	..	13
13 G.M.	5	1	2	1	..	1	..	..	2	..	..	..	..	..	12
14 M.T.	9	..	2	1	..	..	..	..	..	..	..	..	..	..	12
15 T.M.	8	2	..	2	..	..	..	..	..	..	..	..	..	..	12
16 B.V.	4	..	..	..	..	..	..	..	..	..	..	..	..	..	4
17 E.R.	6	3	..	..	..	1	..	..	..	..	..	..	..	..	10
18 F.L.	10	3	..	..	..	..	..	..	..	..	1	..	..	..	14
19 L.G.	6	1	..	..	..	1	..	..	..	..	..	..	..	..	8
20 C.L.	4	3	3	1	..	..	..	1	..	..	1	..	..	..	13
21 M.M.	13	2	..	..	..	..	..	..	..	..	..	..	..	..	15
22 M.W.	9	1	..	2	4	..	..	..	..	..	..	..	..	..	16
23 C.H.	8	2	..	..	..	..	..	..	1	1	..	..	..	..	12
24 V.D.	11	..	..	..	3	..	..	..	..	..	..	..	..	..	14
25 I.S.	10	1	..	..	1	..	..	..	..	..	..	..	..	..	12
26 E.B.	4	1	..	..	..	1	..	..	..	..	1	..	..	..	7
27 M.R.	11	..	..	..	..	..	..	..	..	..	..	1	..	..	12
28 R.W.	8	1	2	1	..	1	..	..	..	..	..	..	..	..	13
29 D.A.	9	2	..	..	..	..	..	..	1	1	..	..	..	..	13
30 D.F.	5	2	..	..	..	..	..	1	1	..	..	..	..	..	9
31 M.E.	4	2	1	1	..	..	..	2	..	..	..	..	..	..	10
32 F.L.	10	3	..	..	..	..	..	..	..	..	1	..	..	..	14
33 J.K.	2	..	..	1	..	..	1	..	..	..	..	..	..	..	4
34 T.G.	7	3	..	..	1	1	..	..	..	..	..	..	..	..	12
35 P.H.	10	1	1	..	..	..	..	..	..	..	..	..	..	..	12
36 M.R.	6	3	..	..	..	1	..	..	..	..	..	..	..	..	10
37 T.J.	10	1	1	5	..	..	..	..	..	..	..	..	..	..	17
38 G.T.	7	..	3	..	..	..	..	1	..	..	..	..	..	..	11
39 R.R.	4	..	..	..	..	..	..	..	..	..	..	1	..	..	5
40 C.B.	7	1	..	..	..	2	..	..	..	..	..	..	1	..	11
Total.....	285	49	26	24	15	13	7	7	7	4	4	2	2	1	446

X.—INFLUENCE OF ERRORS

Classification and Frequency

In order to investigate what different kinds of errors are usually made by students who have passed the beginners' stage and are practising to acquire increased speed, forty students in a senior typewriting class (second year in typewriting) were timed for exactly ten minutes while typewriting from a printed copy of an Underwood test paper, which had not been previously seen or practised by them. Each student was typing at his maximum speed in order to win an Underwood Diploma if possible, and was trying to avoid making any mistakes. The typewritten papers were collected at the end of the ten-minute period and the errors were marked. Their classification and frequency is shown in Table XXXVII of which the following summary is explanatory:

SUMMARY OF TABLE XXXVII

Class.	Nature of Error.	Frequency	Per cent.
I.	Striking wrong letter.....	285	63.9
II.	Omission of letter.....	49	11.0
III.	Transposing correct letters.....	26	5.8
IV.	Omission of space.....	24	5.4
V.	Insertion of space.....	15	3.4
VI.	Omission of words.....	13	2.9
VII.	Repetition of words.....	7	1.6
VIII.	Repetition of letters.....	7	1.6
IX.	Piling letters.....	7	1.6
X.	Letter instead of space.....	4	.9
XI.	Irregular spacing between lines.....	4	.9
XII.	First word of line not at margin.....	2	.4
XIII.	Omission of capital.....	2	.4
XIV.	Paragraph indentation wrong.....	1	.2
Total errors examined.....		446	100%

Causes of Errors

The general psychological explanation of making mistakes in typewriting is variation in degree of concentration, or, in other words, fluctuation of attention and effort. In typewriting, as in everything else, mistakes vary inversely as the attention or concentration, so that mistakes are an indication of the degree of concentration applied to the work.

More particular causes of the above errors and the psychological processes involved in making them have been arrived at from a minute analysis of the above errors themselves, from a critical introspective examination of the writer's state of mind in making errors when typing at maximum speed, and from confirmatory statements of students after their speed tests. Since typewriting is the result of certain motor habits that have become automatic, it follows that manipulation of the machine becomes an act of spontaneous attention. Voluntary attention is required to concentrate on the copy that is to be typewritten, and to put forth effort to reach maximum speed. The above classes of errors on minute analysis may be grouped under two heads, though in some cases they overlap somewhat.

I. Errors of manipulation, caused by spontaneous attention slackening and the brain failing to control the motor function, through insufficient practice. Such errors would include striking a wrong letter in one of the following ways:

- (1) Striking between letters, by reason of overestimating or underestimating the reach required.
- (2) Striking squarely the key next to the one required by overestimating or underestimating the reach required.
- (3) Striking a letter in a similar position on the wrong half of the keyboard, through association of similar positions on keyboard at the left and right.
- (4) Striking a letter in a similar position on the wrong half of the keyboard, through association of similar fingers on the left and

the right hand. The letter "e" struck by the big finger of the left hand and the letter "i" taken by the big finger of the right hand are the letters most frequently interchanged in this way.

- (5) Striking letters on the wrong row of keys by reason of replacing the fingers on that row instead of on the "home" row of keys after return of the carriage.

II. Errors of co-ordination of psycho-motor functions caused by too much voluntary attention being concentrated on the copy to be typewritten, and on effort to advance at maximum speed. The eye advances too quickly over the copy for the physical co-ordinations to take place properly. Too much attention is kept on speed instead of giving part of the attention to the steps necessary to type the desired word or overcome a difficulty. Such errors would include:

- (1) Omission of letters, words, punctuation marks, etc., by not striking the keys at all in the hurry to advance.
- (2) Omission of letters by striking too lightly to mark the paper.
- (3) Omission of space between words by not striking the space bar at all in the desire to get the next word typed.
- (4) Omission of space between words by striking the space bar too lightly to make the carriage move.
- (5) Two spaces instead of one between words by not taking time to press the space bar right down as far as it will go. When pressed down only to the point where it releases the carriage, the carriage may skip along two spaces instead of one.
- (6) Insertion of a space in a word by striking the space bar before typing the last letter in the word.
- (7) Omission of capital. The student perceives the letter required, but in his hurry to go on with the next word fails to grapple with difficulty of use of the shift key.
- (8) First letter of line not at margin. In desire for speed, the student slams the carriage over one space too far, or does not take time to throw the carriage over the proper distance.
- (9) Paragraph indentation wrong. Student does not take time to use the tabular key, and starts the line without indentation.
- (10) Irregular spacing between lines. This generally occurs in double-spaced work. It is caused by the student not taking time to move the line spacer the full distance, and so a single space is left.
- (11) Transposing letters. This is caused many times by reading ahead too fast.
- (12) Piling letters. Student strikes two letters almost simultaneously, the second one printing on top of the first before the carriage moves a space.
- (13) Repetition of letters. Impelled by the idea of speed, the brain fails to control the finger, which is set in action and types the letter twice instead of once as required. The most common one to be repeated in this way is the period at the end of a sentence.

Results of Errors

From a business standpoint the most obvious results are:

- (1) Lessening the value of typewritten work containing errors, as compared with ideal typewritten matter without mistakes. The Underwood and the Remington Typewriter Companies, in all tests for their diplomas and medals, recognize this, and penalize every error by cancelling ten correctly written words. This means that they consider typewritten work to be of no value at all if it has 10% of errors.
- (2) Lowering the efficiency of the operator, as compared with expert operators who make few mistakes. Indeed, the criterion of the expert is "speed with accuracy." The appellation of expert is the result of ability to typewrite at more than ordinary speed with few errors.

From a pedagogical standpoint errors in typewriting have results on the learning process, that are not so apparent to those who are not typists, but students practising to acquire speed are well aware of the following bad influences:

- (1) Errors destroy the morale of the learner. This may be only momentary, or it may extend over a longer time. An occasional student becomes so disgusted with himself for making errors, that he removes his Underwood test, knowing it is no use for him to try during that period. Even the best students find that on making an error their attention is so drawn to the mistake itself and away from their work that a group of errors is made in close proximity before the typists recover their usual composure and confidence.
- (2) Errors cause actual retardation of speed immediately after the learner becomes aware of them. This arises partly from lowered morale preventing the student from doing his best, and partly from interruption of the rhythm with which the individual typist is accustomed to strike the keys. While he is thus thrown out of his stride, as it were, and until he recovers it, his speed is certainly lower.
- (3) Errors often cause the mind of the learner to wander off on unpleasant topics outside of the errors themselves, such as thinking that the other contestants are beating him, etc., thus distracting his mind from the work being done and lowering his efficiency.
- (4) Errors tend to perpetuate themselves in the future. They not only interfere with the learning process at the time they are made, but they tend to project themselves into future practice and interfere with future efficiency. This is especially true of errors of manipulation described above, so that by the law of habit formation there is engendered a motor tendency as well as a mental tendency to repeat the wrong co-ordination or association, and thus interfere with the proper associations required in future correct typing. This has been exemplified often in a class of beginners by a student making a mistake in a

certain letter in one of the words of a line that had to be repeated five times in budget work. The tendency of the same error to be repeated in the case of a line or words all beginning with a difficult letter like "b" or "y", was so overwhelming that the student came and said that he had tried and tried, but could not get that page done correctly. My advice was to go on with the next page, and come back to the difficult one the next day, when it would be done with less difficulty, owing to frequency and recency of association being then less potent factors in recall. In the last batch of papers submitted by senior students typing for an Underwood diploma, there were two students whose work showed examples of this tendency of errors to perpetuate themselves in future work. The word "around" occurred twice in the copy and one student typewrote "aroung" in both these places. The word "were" occurred twice in the same printed copy, and the other student typewrote "wewe" in both these places.

- (5) Error in method of operating any part of the typewriter retards the speed perceptibly; for example, using two hands and making two steps of returning the carriage, moving the paper up a space, and starting a new line, instead of using only one hand and making only one movement to accomplish all this. However, all the results of mistakes mentioned above do not depend on this point, but are based on the assumption that the learner has been taught the best and shortest methods of manipulating each part of the typewriter, as recommended by the makers of the machine.

The value of such an investigation, both to the student and to the teacher, is obvious. The student sees what kind of error he makes most frequently, and can try to avoid it. The teacher, after diagnosing the errors, can prescribe definite corrective exercises on which each student can concentrate in order to try to eliminate his particular trouble. The general remedy for errors is more concentration, both on manipulation and on the copy, with an equitable division of attention between effort to typewrite accurately and effort to typewrite at a fast rate.

XI.—RELATION OF SPEED AND ACCURACY

Ordinarily it might be thought that the slower a person typewrites the fewer errors he would make; but the very opposite is true—the greater the speed the greater the percentage of accuracy in typewriting.

In order to prove this statement, I would like to refer to the World's Championship Typewriting Contests that are held yearly in New York city. An examination of the results any year will show that the majority of those contestants who type at the fastest rates make fewer actual errors than those who type at slower rates.

Last year, in the fifteen-minute tests conducted in our classes for diplomas at thirty net words per minute, medals at forty net words per minute, and bars at fifty net words per minute, with a penalty of ten

words deducted for each error, the following students won these Underwood awards at the speeds shown below, as can be verified by records in the company's office. It will be seen at a glance that the same pupil, with different amounts of practice during the year, typewrote with fewer errors as his rate of speed increased.

TABLE XXXVIII

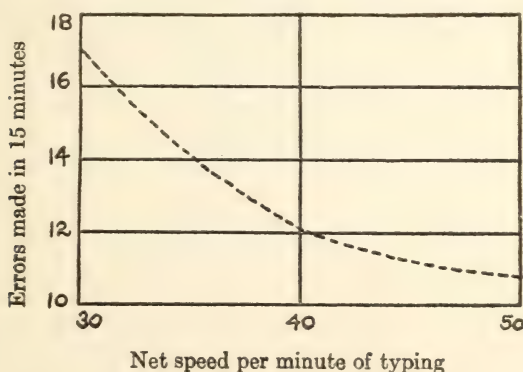
Evidence that Errors Decrease as Speed Increases

Student	Net words per minute					
	30		40		50	
	Gross Words	Errors	Gross Words	Errors	Gross Words	Errors
1 E.G.	667	18	775	12	901	12
2 F.W.	693	14	827	14	800	10
3 C.B.	751	24	825	13	889	11
4 W.K.	678	16	825	11	880	9
5 C.R.	684	23	860	12	889	12
6 G.S.	681	22	868	15	927	13
7 W.H.	666	18	887	18	948	14
8 R.N.	601	10	744	8	832	4
9 M.G.	652	16	790	13	916	16
10 M.M.	622	11	765	8	829	7

The average number of errors made during fifteen minutes by the ten students while typing at the various rates was found from the above table to be as follows: at 30 words per minute, 17.2 errors; at 40 words per minute, 12.4 errors; and at 50 words per minute, 10.8 errors. These averages and speeds are displayed graphically in Figure XXX.

FIGURE XXX

Curve showing that Errors decrease as Speed increases



XII.—INFLUENCE OF CHOICE OF PRACTICE MATTER

Since the Underwood Credential Tests came into existence in 1912, our students have tried each year for Underwood awards in the form of diplomas and medals for speed and accuracy. Two changes were made in our practice material during this time, the influence of which was very significant. As the time devoted to typewriting and the methods used remained the same, I attribute the remarkable results—first, increased accuracy, and second, increased speed—to the influence of choice of practice material.

During the period from September, 1912, to June, 1917, my records show that 150 students won Underwood diplomas at 40 or more net words per minute, with a total of 2,550 errors, an average of 17 errors per student in ten minutes of typing. In September, 1917, the character of the budgets on which the beginners worked was changed. Instead of typing a whole line of the same word taken from a collection of unrelated words, chosen for no other reason than that they could be typed by certain fingers, the students had to type a line in which all the words were different, but involved the same combinations of letters, as described in Chapter II of this dissertation. Thus thoughtless repetition was replaced by repetition with attention, the proper psychological method of habit formation and a necessary condition for maximum efficiency.

In September, 1917, also the character of the practice material used after the budgets were completed for the acquisition of speed was changed. Instead of using alphabetic sentences, in which the letter "z" and letter "x" were typed as often as the letter "e" and other letters of frequent occurrence, an examination of word frequency was made by tabulating the words of many business letters, and the resulting list of words, in order of frequency, was used for speed lessons after this date.

During the period from September, 1917, to June, 1921, my records show that 226 students won Underwood diplomas at 40 or more net words per minute, with a total of 2,006 errors, an average of 8.8 errors per student in ten minutes of typing. Comparing the five years before the change in practice matter with the four years after the change, it is seen that the average number of errors with which Underwood diplomas were won was reduced 50%. The fact that more diplomas were won in the four years than in the preceding five years is of no significance, since the school had grown in the meantime. The main point is that by choice of practice matter the accuracy was increased 50%.

In the five years preceding September, 1917, the penalty exacted by the Underwood rules was five words deducted for each error from the gross number of words typed. Starting with September, 1917, the penalty was increased to ten words deducted for each error, but this new adverse condition made no perceptible difference in our winning Underwood diplomas, since from that date we began to increase our accuracy by 50%.

In the first period of five years, of the 150 students who won Underwood diplomas 7 (or 4.7%) reached a speed of 50, and 13 (or 8.6%) reached a speed of 60 or more net words per minute; that is, 13% of the total number were typing over 50 net words per minute with a penalty of five words off for each error. In the second period of four years from September, 1917, of the 226 students who won Underwood diplomas 10

(or 4.4%) reached a speed of 50, and 30 (or 13.3%) reached a speed of 60 net words per minute; that is, 18% of the total number were typing over 50 net words per minute, with a penalty of ten words off for each error. Thus it can be seen that, not only was accuracy increased, but also, speed was increased.

XIII.—CORRELATIONS OF TYPEWRITING ABILITY

Correlations of initial ability in typewriting with intermediate and final ability of the fourteen students who remained at school throughout the whole experiment, were found by using the ranking from the scores for each of the four periods in the investigation. These periods are: (a) 1-35 hours; (b) 50-90 hours; (c) 100-240 hours; (d) 250-360 hours. The scores of each student over each of these periods were averaged and the resultant scores are shown, along with the ranking, in Table XXXIX.

TABLE XXXIX

Ranking of Typewriting Ability at Different Periods

	Hours 1-35		Hours 50-90		Hours 100-240		Hours 250-360	
	Average Score	Rank	Average Score	Rank	Average Score	Rank	Average Score	Rank
1 D.A.	19	10	121	8	208	10	254	12
2 V.B.	18	11	111	11	200	12	276.6	5
3 V.D.	20	8	112	10	197	13	277	4
4 C.H.	18	11	98	13	229	5	262	10
5 M.M.	11	14	76	14	155	14	230	14
6 P.N.	27	4	138	3	227	7	304	1
7 J.P.	18	11	129	5	211	9	255	11
8 M.R.	20	8	119	9	207	11	249	13
9 I.S.	22	6	107	12	251	1	276.2	6
10 E.T.	31	2	130	4	218	8	265	8
11 R.W.	31	2	141	2	233	2	263	9
12 M.W.	22	6	125	6	232	3	274	7
13 D.W.	42	1	151	1	228	6	278	3
14 R.W.	24	5	123	7	231	4	288	2

Correlations found from the above rankings by Pearson's Modification of the formula for correlation of grades are shown below:

Initial ability with second period ability . .	.80	± .0360
Initial ability with third period ability . . . .	.61	± .1134
Initial ability with final ability . . . . .	.59	± .1175

The meaning of these correlations is that in a class of students learning typewriting by the touch method, those with ability above the average at the end of thirty-five hours of practice will tend to have final ability above the average, while those with poor initial ability will tend to have poor final ability.

Correlation was also investigated between final ability or speed in typewriting and mental ability as indicated by proficiency in school subjects. These fourteen girls were in their final year studying seventeen subjects, and examinations were held and reports were issued at No-

vember, Easter and June of that year. The marks for each student covering these three examinations in the seventeen subjects were combined and the ranking was found as shown in Table XL.

TABLE XL

Student	Ranking of Same Students in School Subjects															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
	D.A.	F.B.	V.D.	C.H.	M.M.	P.N.	J.P.	M.R.	I.S.	E.T.	R.W.	M.W.	D.W.	R.W.		
Rank...	4	9	2	12	11	10	14	8	5	6	3	7	1	13		

Using the ranking in Table XL and the final speed ranking from Table XXXIX, correlation was calculated by Pearson's Modification, and found to have .17 for coefficient. The significance of this coefficient is that correlation is very small indeed, and that there is practically no agreement or connection between mental ability as judged by school subjects and improvability or speed in typewriting.

XIV.—SUMMARY AND CONCLUSION

The following is a brief summary of the results of the investigations described in the preceding chapters of this dissertation: (1) The activities and methods previously learned in piano playing are favorable elements in learning to typewrite; (2) girls as a group reach higher efficiency in typewriting than boys as a group can reach; (3) Jewish students are slightly superior to non-Jews in learning to typewrite; (4) beginners aged twelve years are less efficient than beginners aged from thirteen to seventeen, while beginners aged from eighteen years on appear to diminish again in ability to learn typewriting; (5) regularly attending night-school beginners in typewriting achieve 40% less work and make a total of 100% more errors than regularly attending day students, or, if we take into consideration the work actually done, 167% more errors; (6) each day-school student on the roll achieves 80.6% more work than each night-school student on the roll, owing to the enormous elimination of evening students; (7) there is a great permanence in the learning of typewriting and a high degree of retention of old skill, as shown in the relearning of typewriting; (8) returns in efficiency diminish gradually as practice is prolonged after about ninety hours; (9) errors have a psychological as well as practical effect in retarding improvement in typewriting; (10) accuracy increases with speed; (11) choice of practice material affects speed and accuracy; (12) initial and final typewriting ability correlate with a high coefficient, but mental ability and speed in typewriting show practically no correlation. An obvious conclusion to be drawn from the above summary of results is that improvability in typewriting is more or less amenable to many complex and subtle influences, both internal and external to the learner.

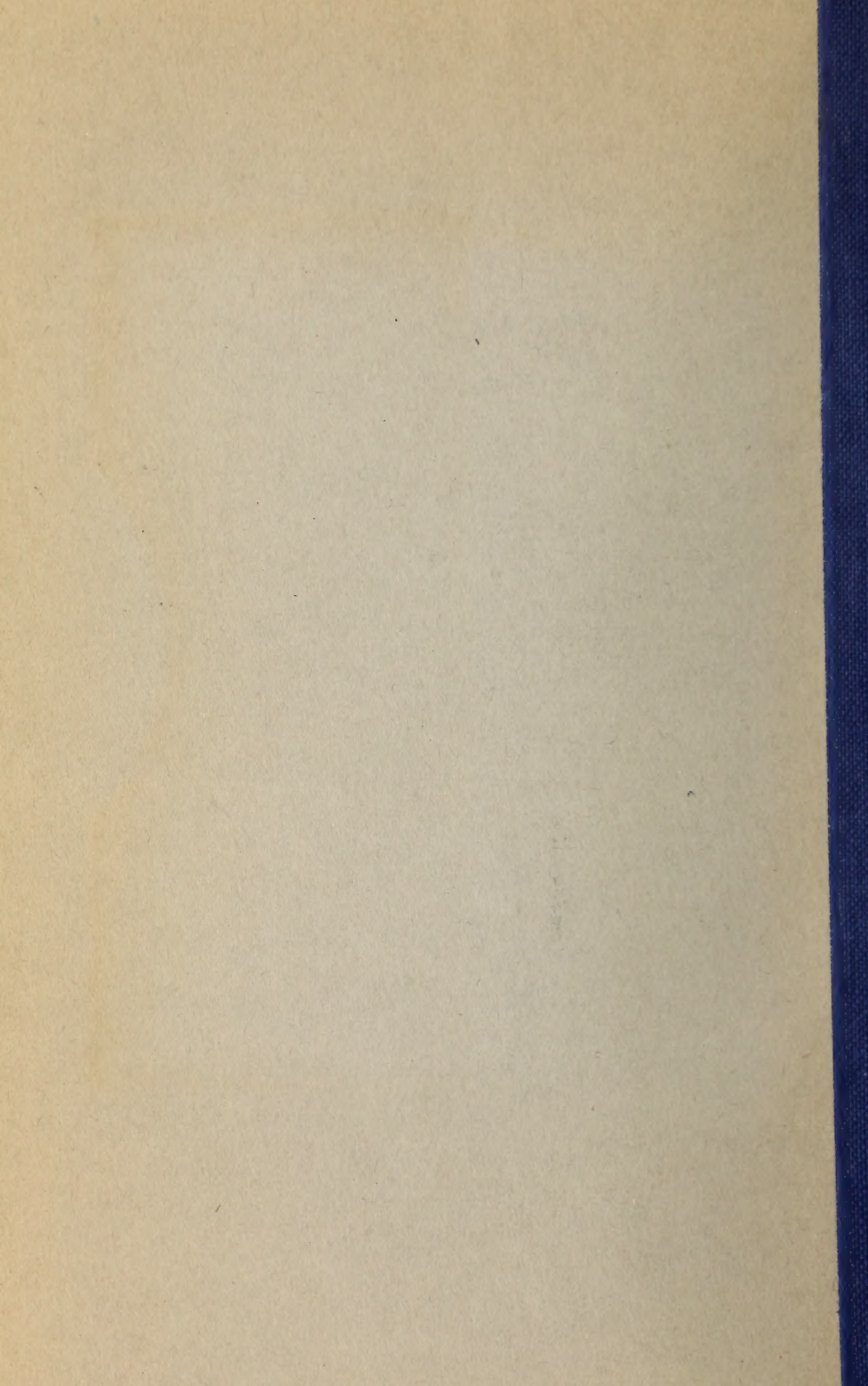
A conclusion to be drawn from the fact that improvement continued to accrue from practice during three school years and was not then exhausted, is that touch typewriting is a function the complexity of which requires a prolonged period of practice before the limit of improvability is reached. Its complexity is seen in the use of all the fingers of both

hands on the keys and the right thumb on the space bar, the eyes watching the copy on the desk, and the attention being divided among copy, machine, speed and accuracy. All this entails numberless mental and motor adjustments. While the learner is adapting himself to the work, he gradually replaces initial temporary habits by permanent habits for economy of movement. This adaptation takes a long time to perfect before the limit of improvement is reached.

The complete learning curve for the three years is obtained by viewing its cross-sections shown for the three successive periods of practice. On examination we find that this curve has the following characteristics: (1) There is a fairly rapid initial rise. There are no noticeable deviations from this almost straight line as it rises to form a rather steep slope, thus indicating that the first ninety or one hundred hours are an initial period of steady improvement, with uniform increments of speed per hour of practice. (2) This is followed by a less rapid rise from the 100th to the 240th hours, indicating slower progress and diminishing returns in efficiency as practice continues. This cross-section is really an extensive and slightly inclined plateau on the complete learning curve. (3) The final portion of the curve, the cross-section between the 250th and 360th hours, scarcely rises above the horizontal in general direction of progress. This is a period of very little progress. It is really an extended horizontal plateau with slight spurts above and relapses below the horizontal line, and is indicative of the approach of the physiological limit of speed for these students. In conclusion, it would seem that the learning curve for typewriting conforms pretty closely to the established characteristics of practice curves in general, and that the learning process in touch typewriting is very similar to that of other mental and motor functions exercised in the acquisition of skill.

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